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STUDY YOUR MEN

REMINISCENCES OF A LONG-TIME CHIEF

A goodly share of the pleasures of youth is derived from anticipation. But as one gets along in years, he acquires a habit of looking back—of reviewing, as it were, the events of his past life. The anticipations of youth will never again be his. Whether we of gray hair and faltering step are able to derive pleasure from retrospection depends on the way we have conducted ourselves and the business of those who have, down through the years, placed their trust in our ability.

FUNNY how the time flies! Seems only a few days ago that I got my first job in a power plant, and yet what I read on the calendar informs me that forty years have passed since that event. Little did I realize at that time what a momentous occasion it was. Then I was young and life was all before me. Now I am gray, and although my years of usefulness are not quite over, the time is not far distant when I must step down and let a younger man take my place.

Well do I remember the day, forty years ago, that I started to work in the occupation which I have followed ever since. From the first I liked it and straightway decided that I would make it my life work. I have never regretted making that resolution. The way has often been anything but smooth and I have had my share of difficulties to overcome, but I would make the same decision today, knowing what I do, that I made forty years ago.

The first plant I worked in was at that time considered a "whopper," although today it would seem very small compared to the one I am now in charge of. I was put to work hauling in coal and taking out ashes and in other ways making myself useful to the fireman. The interest I took in that work was soon repaid, for the first vacancy in the fireroom force was given to me. That gave me a small increase in pay and stimulated my desire for further promotion.

I will not go into detail as to the various promotions I received after being given the job in the fireroom. I was young and ambitious and made use of every opportunity that came along to learn something that would be of value to me in my work. The result is—well, my record speaks for itself.

LIKE most young men who enter power-plant work and decide to make it a life's occupation, I soon developed an ambition to be a chief. I had not been long in the fireroom when something occurred which has been largely the cause, I believe, of the success with which I have been able to handle the men who have been under me at various times and places since being placed in executive authority. This is what happened: One of the firemen incurred the displeasure of the chief. Now, this fireman was a first-class man at his work, as men were rated in those days; but for some reason which I cannot now recall, the chief engineer "bawled him out" one day before a group of his fellow workers. The change in the man was remarkable. Where before he had taken an active interest in his work and really was the best fireman in the place, after the chief censured him in our presence, he lost all interest in the plant and became practically useless. The chief finally discharged him.

Right there I made up my mind that in my preparation for a job as chief, I would study not only the mechanical intricacies of power-plant apparatus, but also the human element, which constitutes so vital a part of plant equipment. I had seen a first-class man ruined, for that particular plant, by a chief engineer who, though well-meaning and a high-grade man mechanically, had something to learn about handling the men in his charge. That occurrence set me thinking, and I learned a lesson from it that has served me well many times since. The result is that during all the years I have been in charge of men I have seldom had to discharge one, and all those who have resigned have left me with their good will and best wishes. I have always made special efforts to maintain harmonious working organizations, for I learned early in the game that an organization that pulls together is the only kind worth maintaining.

I ATTRIBUTE my success partly to the fact that I started at the bottom—on the ash dump—and have spent some time on every rung of the ladder from the bottom up. If one of my men comes to me with a grievance, I can meet him with understanding. Because of my own experience in all phases of power-plant work, I can place myself in his shoes, mentally, and in that manner understand his problem. In fact, I believe that the faculty of being able to see things from the other fellow's point of view as well as your own is essential to one's success as an executive.

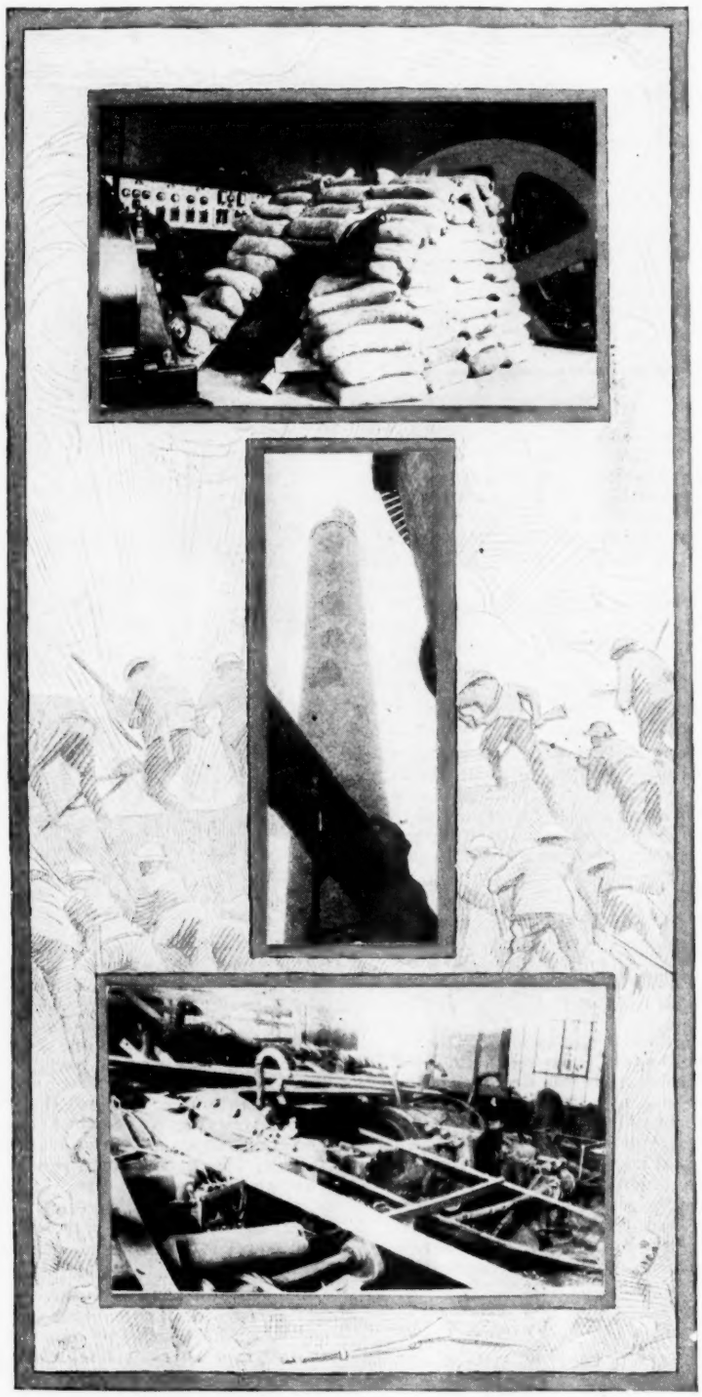
My years of experience have demonstrated beyond a doubt that in order for one to obtain and retain the respect and loyalty of those in his charge, he must be somewhat of a psychologist. No two men are just alike, and each requires a little different handling in order to bring out the best in him. If there is one thought I would leave with the young men who a few years from now will fill the places left vacant by the veterans, it is this: Study your men. Don't devote your whole time to the inanimate equipment. You will find that in order to build up and maintain an enviable record as a chief engineer, you must have the good will and loyal support of those under you. You cannot have that unless you *know* them, and you cannot *know* them unless you make special efforts with that end in view.

Contributed by H. G. Gibson, Washington, D. C.

Operating a Plant in the War Zone

By A. R. Decker

Notwithstanding low production costs the iron-pipe plant at Pont-à-Mousson, France, is far from modern in equipment or operation. Old, ill-lighted buildings and ancient equipment do not tend toward high efficiency. One of the newest and best-adapted buildings in the big group is the electric station. This is a stone and reinforced-concrete structure composing one large hall housing a number of Diesel engines. A typically French, red-tile roof makes the building stand out from its older and more dingy neighbors. Near-by is the power-station repair room and storehouse, touching the framework of a new building destined to hold another group of Diesel engines. One of the assistant engineers of the plant was in Germany, buying the new engines and accessories when the war broke out. I don't know yet what became of him. However, we had no immediate need of his equipment, because, since the outbreak of hostilities, the war has been waged around the factory. After a short but anxious month of bombardments, the Germans arrived in town. I watched the whole proceedings, going to and from the plant as usual. One incident in particular struck my attention. A wire-stringing squad of two soldiers of the signal corps came down the main highway, one soldier riding a horse and paying out telephone wire from a spool. The other German followed, fastening the wire to convenient trees or walls, by means of a long-handled hammer and some insulators. Arriving in front of the power station, the two stopped for a moment, for at this point they had to bring their wire across the street. However, it required but an instant for the soldier riding the horse to pull out his map and then direct the man on foot to carry the spool through our transmission conduit, although some of us hardly knew where the entrance was! In the seesaw of battle the Germans retreated and intrenched in the hills, about two kilometers from the plant. They held the height called the "Haut de Rieupt," from which their observers could count every workman checking-in at the factory; that is, when any workmen were checking-in! We piled hundreds of bags filled with dirt or iron filings around the motors, generators and switchboard, in order to protect them from the projectiles. For a time this protection sufficed, as the German gunners were content with firing shrapnel and small percussion projectiles. However, the tile roof looked like a sieve because of the neat round punctures made by the shrapnel slugs. It was not long before the German gunners got busy in earnest, and a battery of 8.4-in. howitzers was directed toward the region surrounding the electric station. At this time a company of French infantry was quartered in the strong cellars. During one of the heaviest bombardments I happened to be within sight, but at a respectable distance. The projectiles rolling along overhead seemed like a thousand elevated trains. From the electric station clouds of smoke rose, and débris spouted in the air. The half-filled-in framework of the power plant addition became a skeleton of twisted steel; the repair shop and storehouse collapsed, and finally, to finish the day's work, a high shot took the top off the chimney of the auxiliary steam plant.



GENERATORS PROTECTED WITH BAGS OF CEMENT, AND SOME RESULTS OF THE BOMBARDMENT

Ford Boiler and Gas Plants

By Thomas Wilson

SYNOPSIS—Boiler plant to contain seven and probably eleven of the largest boilers in this country. They are of the six-drum six-pass type with a special economizer section at the rear. Each boiler will have 25,000 sq.ft. of heating surface and will be served by a 12-retort underfeed stoker. Steam will be generated at 180 lb. pressure and superheated to 600 deg. The coal-handling equipment is unusually complete, and the ashes will be cared for by a pneumatic vacuum system. The use of instruments will be profuse so that all data relating to boiler plant operation will be available.

In the Ford boiler plant seven of the largest boilers yet to be put in operation are in the course of erection. They are of the six-drum type with six passes for the gases, and with 25,000 sq.ft. of heating surface are rated at 2500 hp., although it is proposed to operate them

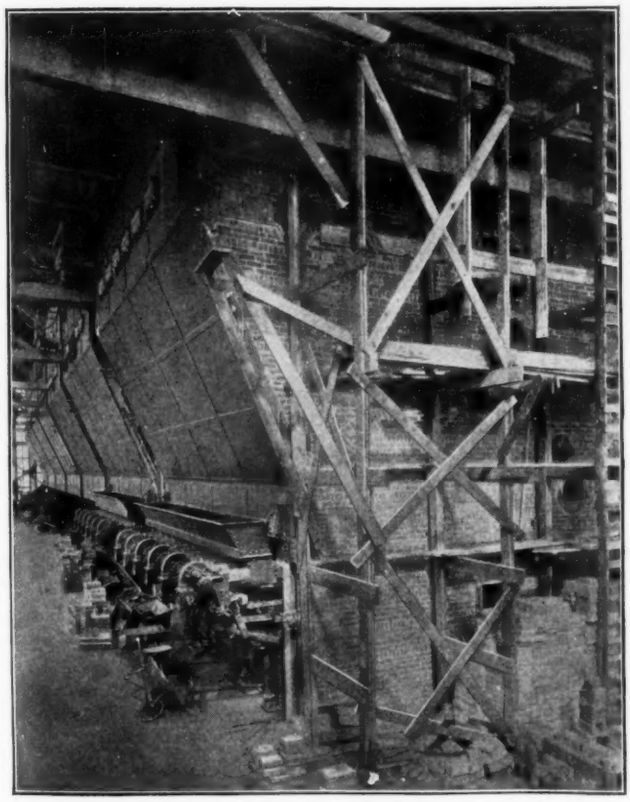


FIG. 1. SEVEN BADENHAUSEN BOILERS UNDER ERECTION

continuously at 4000 hp. Steam will be generated at 180 lb. pressure and superheated to a temperature of 600 deg. F. As explained in the Oct. 3, 1916, issue of *Power*, the units are single-ended, the boiler proper consisting of three drums and three banks of tubes arranged in triangular form. Above these is a superheating drum and at the rear an economizer section consisting of two drums and interconnecting vertical tubes.

As intimated in a previous article, the boilers are installed on the third floor of the power-plant building in a room having interior dimensions of 95x245 ft., with headroom of 24 ft. from the floor to the sway bracing and 53 ft. to the roof girders. The seven new Badenhausen boilers, set singly with a 3¼-ft. space between, take up one side of the boiler room, leaving a space of 28 ft. at either end and a distance from the stoker ex-

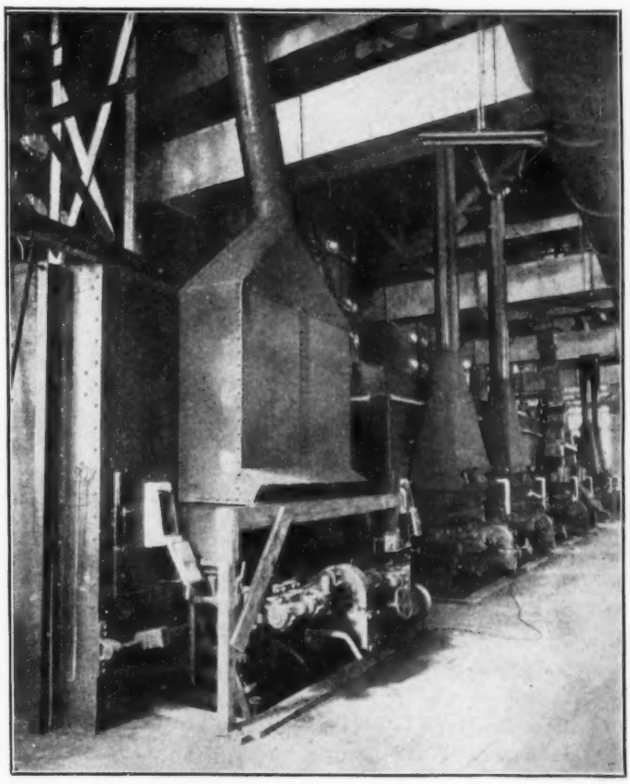


FIG. 2. SEVEN 400-HP. WICKES BOILERS WHICH ARE NOW IN SERVICE

tremities to the wall of 11 ft. On the other side seven 400-hp. Wickes vertical water-tube boilers have been installed and are now supplying steam to the engine room. In the remaining space it is proposed to install four

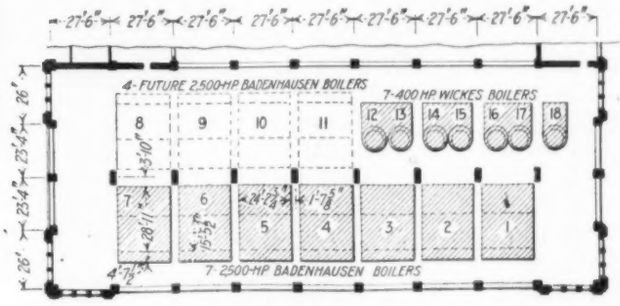


FIG. 3. PLAN OF BOILER ROOM

more of the large boilers. The latter are set high, 35 ft. 8 in. from the floor to the steam outlet, allowing an indenture at the rear under the lower drums of 14 ft. 6 in., with a headroom of 7 ft. This space will be utilized for blowoff piping, boiler feed-water headers and miscellaneous small piping located high enough to per-

mit a continuous passageway from side to side. Headers for the water backs will also be located here, and there will be two furnace observation doors in addition to the usual doors in the side walls. The boiler fronts are indented 4 ft. 7 in. at the furnace, so that the extremities of the stokers come within the overhang. In this way a boiler that would otherwise occupy a floor area of 804 sq.ft. actually covers at the bottom a floor space of 346 sq.ft., or the area under the furnace, measuring 14 ft. 5 in. deep by 24 ft. wide. Including the front overhang the nonusable space occupied by each boiler is 456 sq.ft., or 0.114 sq.ft. per horsepower of the normal 4000-hp. operating load. The settings will be made up of the usual brick with a coating of asbestos cement to make them air-tight. Each boiler will be served by a 12-retort Taylor stoker of specially large size. It will be driven by a variable-speed motor mounted on the floor and connected to the stoker shaft by a silent chain drive. The range of motor speed will be from 300 to 1200 r.p.m. and the reduction 3 to 1. Clinker crushers are provided, with a 5-hp. constant-speed motor at either end, mounted on the ceiling of the ashroom. The drive is by belt, gear box and ratchet, the throw of the later being adjustable. The water-back is of special design. It consists of two headers in the open space at the rear of the bridge-wall with 3¼-in. U-shaped tubes, spaced 6¾ in. apart, passing through the bridge-wall and projecting far enough to prevent clinker coming in contact with the brickwork. Expansion is taken care of by arranging the brickwork to give a space of ½ in. around the tubes, which space is packed with asbestos. By drawing them into the furnace the tubes can be removed without seriously interfering with the bridge-wall. The headers are provided with suitable handholes through which the tubes may be expanded or cleaned. By long bends, the headers are flexibly connected to the boiler. Four tubes at the rear of the economizer bank pass by the lower drum and connect into the lower header of the water-back, the return connections being from the top header through four tubes at the front of the section. As the feed water enters at the rear, the coldest water in the boiler goes to the water-back. The flow enters into and assists the regular circulation of the boiler. There are four blowoff connections to each boiler—two on the lower drum of the economizer section and two on the lower drum of the boiler proper. Each connection has an angle and a straightway valve, and all lead to a central blowoff tank having a 10-in. vent to atmosphere and an 8-in. overflow to the outside sewer. To give the high superheat anticipated, a Superno superheater is located between the first and second passes, or in the path of the gases just after the first bank of tubes. To obtain uniform heat transfer, the superheater is made up with an increasing number of tubes of decreasing diameter but constant area approximately equal to the steam-outlet area from the boiler.

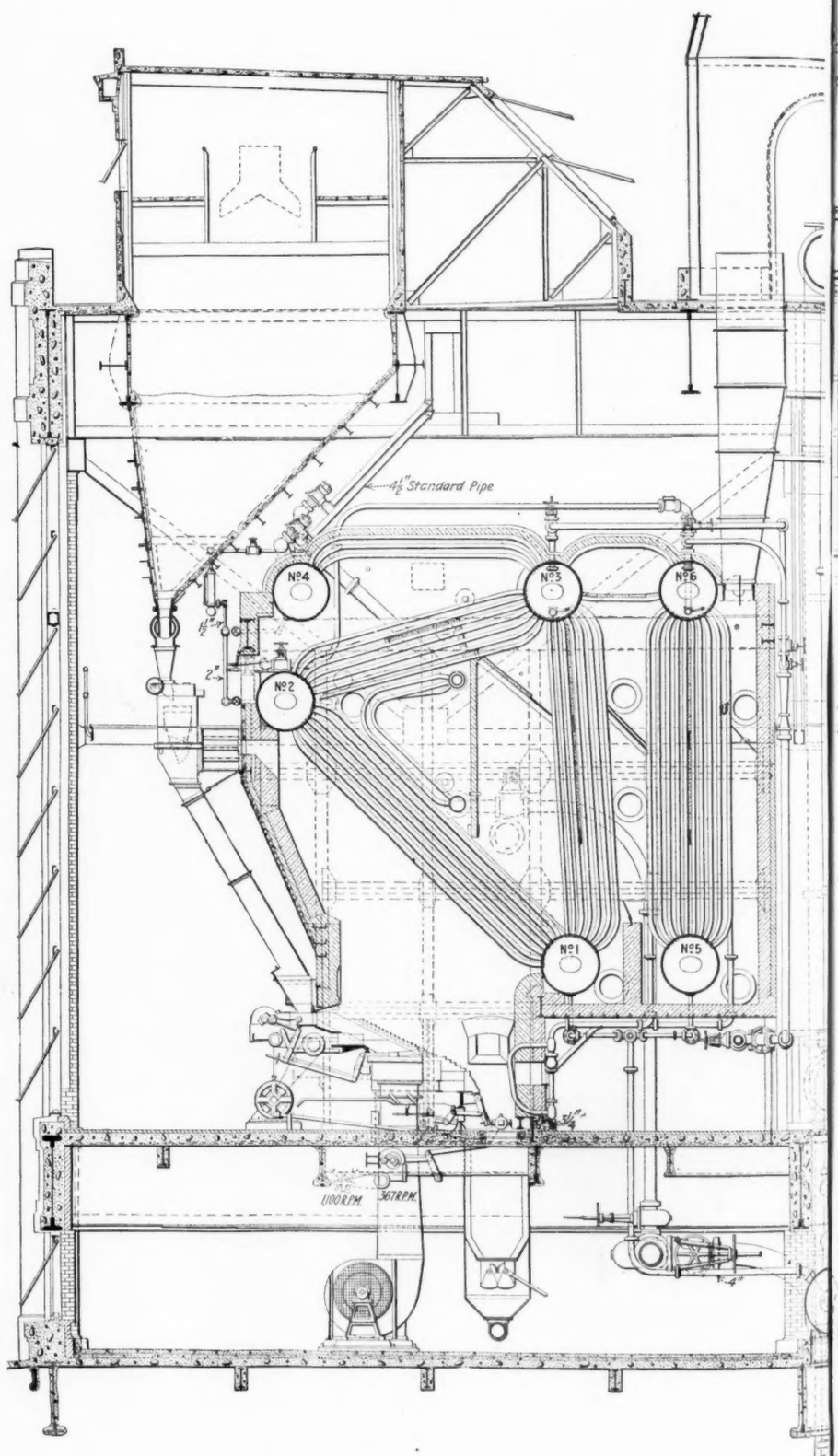
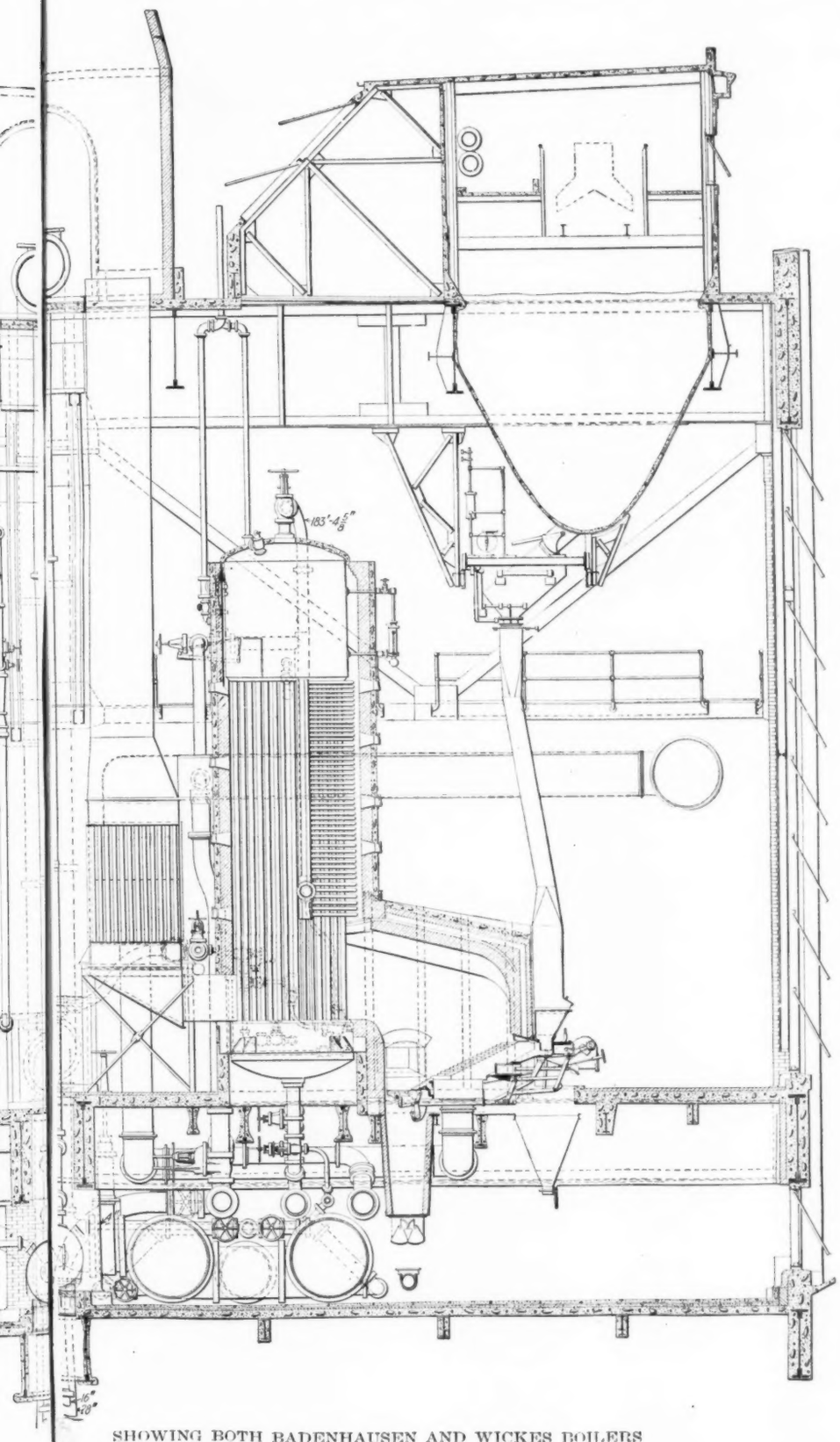


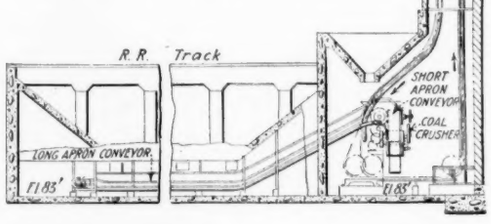
FIG. 4. SECTIONAL ELEVATION ACROSS BOILER ROOM

Another feature is a damper between the third and sixth passes. This is hinged onto the boiler side and closes against angle iron on the division wall between the two lower drums. Normally, this damper will be closed and all of the gases will flow through the six passes of the boiler. Should the draft be lower than usual and it is desired to reduce the drop through the boiler, the damper will be raised so that a portion of the gases will enter directly from the third into the sixth pass. The flow from here is upward through a vertical uptake into one of the five steel stacks serving the boilers. When the plant is complete, it is planned to induce the draft by utilizing the exhaust from the gas engines. It is expected that the temperatures of both exhaust and stack gases will approximate 300 deg. F., so that reliance will be placed upon the velocity of the gas-engine exhaust to increase the draft. The self-supporting steel stacks have an external diameter of 12 ft., decreasing to 11 ft. inside the lining. On the interior the metal is painted with red lead and two coats of graphite. Up to 28 ft. from the top there is a lining of Custodis radial block and above this a 2-in. coating of "gunite" covered with a coatting of heavy paint. The stacks, which are supported on the roof girders, are 156 ft. high, the top being 207 ft. above the boiler-room floor. An unusual feature is intermediate breechings between stacks so that any two or all may be thrown in together. Each breeching has a damper which is operated from the roof, and normally, this will be closed so that the stack will operate independently. Forced draft is supplied to each stoker by two 21,000-cu.-ft. double-inlet conoidal fans mounted on one sub-base and driven through flexible couplings by a 100-hp. motor. The unit is mounted on the ash floor with direct vertical connections to the windboxes of the stoker. The fans will furnish a maximum pressure of 6½ in. of water. A central girder under the furnace and comparatively low headroom made the double unit desirable. It fits well the space under the stoker and facilitates air distribution. On the opposite side of the boiler room seven Wickes boilers containing the latest improvements have been installed. They were originally intended to operate in conjunction with gas producers, but lack of space for the boiler capacity demanded by the rapidly increasing load prohibited this arrangement. Each boiler has 4000 sq.ft. of heating surface and is equipped with a four-retort Taylor stoker that is driven by an individual vertical engine mounted on a base at the side of the stoker. The furnace is of the usual dutch-oven type with a ventilated arch. The setting is lined with Nonpareil insulating block and is steel-jacketed. Steam is generated at 180 lb. pressure and at present is superheated to 600 deg., the superheater being of the same type employed in the larger boilers. With the boiler-feed water raised to a high temperature in the gas-engine cylinder jackets and the feed-water heaters, the heat in the stack gases is utilized



SHOWING BOTH BADENHAUSEN AND WICKES BOILERS

in an air preheater rather than in an economizer. The preheater consists of a rectangular sheet-iron box, with tube sheets and 190 tubes of 3½ in. outside diameter spaced on 6-in. centers both ways, set in the uptake from the boiler. The gases pass through the tubes. The air from the fan comes in at the side of the preheater, flowing across the tubes and back to the outlet, thence down through a duct to the windboxes of the stoker. A series of sleeves with baffle flanges fit over the tubes to increase the area of contact and to stratify the air so that all the surface will be utilized to advantage. Two fans, having a capacity of 48,000 cu.ft. per min. each, serve the seven stokers. One is driven by a motor and the other by a steam turbine, the former being located in the engine-room basement to recover the radiated heat and ventilate as well. As has been stated previously, the boiler-feed water comes from the pressure tanks on the roof, flowing through the gas-engine cylinder jackets and up to the suctions of the boiler-feed pumps located on the engine-room floor, thence through inclosed heaters receiving the exhaust from the gas engines, to the boilers. One of the feed pumps is of the Hamilton crank-and-flywheel type with a duplex 8x30-in. water end driven by a cross-compound 12 and 24 by 30-in. Corliss engine operating against a 26-in. vacuum supplied by a surface condenser. There is a service pump of the same type that may be used for boiler feed and one eight-stage Rees-Roturbo 1200-gal. pump designed to operate against a head of 250 lb. Each heater unit is divided into four elements



receiving the exhaust and the jacket water from three engines. The gases pass through the four elements in series counter-current to the flow of the water. It is estimated that they will enter at a temperature of 550 deg. F. and leave at possibly 300 deg. The water leaves the gas-engine jackets at an average temperature of 195 deg. and it may reach a temperature of 275 deg. in the heater before being delivered to the economizer sections of the boilers. More definite data will be available when the heaters are installed and in operation. They will be located on the ash floor immediately under the boilers. A bypass around the heaters is provided so that they may be cut out for inspection or repairs. A combination gate and check valve in this bypass automatically opens at a predetermined back pressure, thus safeguarding the atmospheric relief on the steam end, which connects with the gas-engine exhaust piping, should the valves at the heater be closed.

Each element is a special Kelly heater of the closed type with one floating head so that the tubes may be pulled out as a unit for cleaning or inspection. The shell is 5 ft. in diameter and has an over-all length of 21 ft. 2 in. Each heater contains 3900 sq.ft. of surface in "Armco" iron tubes, which will withstand sulphuric acid better than the usual cast iron. The heaters have 8-in. water and 38-in. gas connections.

All steam piping, fittings and valves are made of steel, and wherever possible long bends are used to provide for expansion due to the difficulty of packing expansion joints at the high temperature. In the main header on the ash floor and in the vertical risers leading to the engine-room basement some expansion joints have been employed owing to lack of space for bends. All joints are of the Van Stone type, while the valves are of the

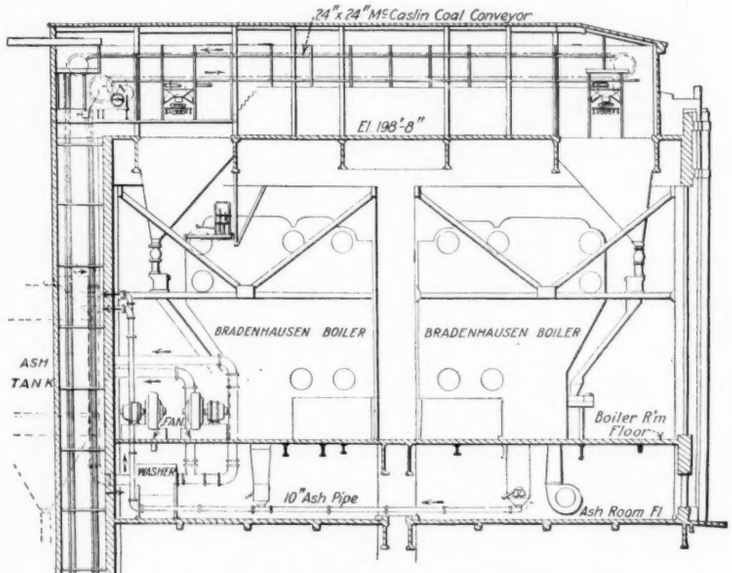


FIG. 5. THE COAL-HANDLING EQUIPMENT AND PNEUMATIC ASH CONVEYOR

Lunkenheimer wedge-gate type employing monel metal seats and of the Chapman double-gate type for superheated steam.

From each large boiler there are two steam outlets, both leading from the upper front drum and down on either side of the setting to the superheater inlets. There are also outlets from the superheater on either side mounting a triple-duty stop and check valve and a 3-in. safety valve, the latter being set to blow at a few pounds less than the main safety valves, of which there are nine, 4½-in. diameter, mounted on three multiple fittings leading from the upper front drum of the boiler. The smaller safety valves protect the superheater against a sudden stoppage in the flow of steam due to the closing of the automatic valves. From the superheater, 8-in. steam leads pass down on either side of the boiler to a 16-in. header on the ashroom floor. From the header supply lines drop to the basement to serve the various engines, also to various points of the factory.

Ashes are removed by a Guarantee pneumatic vacuum system equipped with an elevated ash tank large enough to hold the ashes from a 12-hr. run of the plant. The tank has been placed on top of the coal-storage house and is so situated that after a coal car has been emptied it may be refilled with ashes without being moved. Under each furnace there are double ash hoppers from which the ashes drop directly into extension hoppers on

the 10-in. ash line. Around the inlets to the carrying pipe concrete piers have been provided to furnish solid surfaces on which to break any clinker too large for the system to handle. There will be an ash line under each row of boilers running the full length of the room. After passing all service points, the pipes rise vertically about 60 ft. and then pass out through the boiler-room wall into the top of the ash tank. The longest horizontal run is nearly 250 ft., and the other 20 ft. less.

From the tank the suction pipe passes to the ash-room floor, entering the dust collector, consisting of a main separating chamber, suitable baffles, water sprays and a sludge tank, and from here the suction continues to duplicate fan units on the boiler-room floor. The equipment here consists of two General Electric centrifugal compressors, each driven by a 75-hp. motor and discharging into separate vents leading through the boiler-room wall to the atmosphere. At the entry end of the system the ashes are handled slightly wet. As a protection against corrosion the tank is lined with cement. The capacity is 500 lb. of dry ashes per minute.

West Virginia run-of-mine coal, the variety used in the plant, is brought in over a railway siding to the coal-storage house. Provision is made for bottom- or side-dump cars to discharge into a track hopper having a capacity of 800 tons. This hopper may overflow into a 1200-ton storage bunker at the side, or the coal may be unloaded directly to storage by an overhead traveling bridge crane with a 1½-yd. bucket, the same crane being usable to transfer coal from storage to the track hopper or to an emergency bin discharging directly to the coal crusher.

Coal Conveying Equipment

From the track hopper the coal passes through 24x24-in. duplex valves to a 30-in. steel apron conveyor, motor-driven at a speed of 37 ft. per min. and having a capacity to handle 150 tons of coal per hour. A short cross-conveyor receives the coal from the apron and delivers it to a single-roll crusher, from which it may pass through a bifurcated spout to either one or to two McCaslin bucket conveyors driven at a speed of 50 ft. per min. by 20-hp. motors. Each conveyor has a capacity of 75 tons per hour. On 13-ft. centers the two conveyors encircle the end of the boiler room. On the upper run dump blocks discharge the coal onto either one of two 30-in. belt conveyors running over the bunkers on either side of the boiler room. At a speed of 225 ft. per min. the belts each have a capacity of 85 tons per hour.

On the Badenhausen side individual 135-ton steel bunkers of the hopper type with two outlets have been installed. Through a rotary valve the coal is fed from each outlet into a 150-lb. Richardson automatic weighing machine of the inclosed type, which is provided with a counter to record the weights. The coal then passes through a dust-tight spout flared at the end to fit over the stoker magazine, observation doors being provided in the flared end of the spout.

Individual suspension bunkers holding 65 tons each serve the Wickes boilers. Through side outlets in the bunkers the coal is fed into a 1-ton traveling weighing device provided with a beam scale and a stamp to record the weight. The device is electrically operated and discharges to any one of the seven stokers through dust-tight spouts similar to those on the other side.

Plans are under way to provide a meter room in which all data relating to boiler-room operation will be available. For each of the large boilers there will be an electric pyrometer. Eight different thermocouples will be placed at various points along the gas passages in the boiler on either side. The wiring connections will lead to a common board containing an equal number of push-buttons and the instrument to give the reading. There will be steam-flow meters, indicating and recording pressure gages, draft gages, CO_2 recorders, water-level indicators, venturi meters on the feed line to each boiler and perhaps other meters and gages.

The Gas Producer Plant

Owing to the rapidly increasing demands of the manufacturing plant, it was soon evident that there would be no space available for the gas producers in the boiler room, as originally intended. The present gas plant is only temporary and will be superseded in the near future by a permanent gashouse having ample capacity to serve the engines and the factory. The equipment now consists of five Hughes producers, each having capacity to gasify one ton of coal per hour and to supply 2500 cu.ft. of gas per minute having an average heat value of 140 B.t.u. per cu.ft. Three of these producers operate on West Virginia bituminous coal containing 13,500 B.t.u. per lb. and the other two on pea coke. The gas from the producers running on coal is passed through a washer cooler, thence to an electrical detarrer. Mechanically this consists of an 8-ft. length of gas main with an electrode suspended through its center. One lead from the high side of a potential transformer is connected to the pipe and the other to the electrode inside of the pipe. Turning on the current produces a high stress on the dielectric inside the pipe along with a brush discharge. In the field of high stress the gas becomes ionized and the ions of gas attaching themselves to the tar particles give them a much higher velocity. The rapidity of condensation or agglomeration of the tar vapor is attributed to the high velocity or increased agitation among the particles which this method insures. The gas is now passed through a standard cleaning or washing scrubber where grids collect the tar, which is readily removed to storage tanks. No cleaning apparatus is used for the producers operating on pea coke other than a cooling tower.

Recently an experimental producer was built to make gas which would not require scrubbing apparatus. The outfit consists of a standard Hughes producer fed with coal and discharging gas to another producer of special construction charged with coke. The tarry vapors in the gas from the first producer are fixed into permanent gases by passing through the bed of hot coke in the second machine. This unit is now in operation.

The latest addition to the gas department is a Smith producer plant consisting of two units each capable of gasifying two tons of coal per hour and supplying 5000 cu.ft. of gas per minute having a heat value of 150 B.t.u. per cu.ft. Each producer has a 45-cu.ft. exhauster driven by a 11x24-in. twin Hamilton Corliss engine. The gas is cleaned by the regular spun-glass filters used with these producers. It is delivered to the power house through a 42-in. spiral pipe main 600 ft. long, the line having a capacity to supply the six engines of the present plant. A 30-in. line carries gas to the factory for heat-treating and other furnaces.

Reconnecting Induction Motors—Types of Windings

By A. M. Dudley

SYNOPSIS—General considerations affecting windings, the different kind of changes that may be made and the usual form of induction-motor winding are described. The first article, Jan. 16, 1917, mentioned the reasons for reconnecting motors. It also explained the manner of setting up a rotating magnetic field by the use of alternating current and described the three functions of the windings in an induction motor.

An electric motor is a device for transforming energy in the form of an electric current into mechanical energy in the form of turning effort, or rotating force. This turning effort, or driving force, is called torque and is measured in the pounds pull that a motor would develop at the rim of a pulley one foot radius. This torque is produced by the force exerted by a current flowing through a conductor located in a magnetic field. From this it is evident that the capacity of a motor to produce torque is limited both by the capacity of the

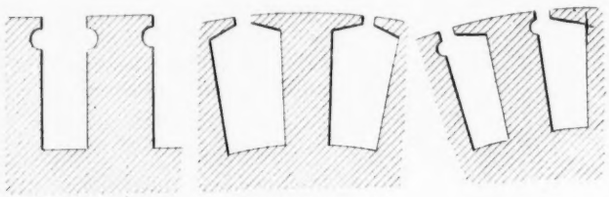


FIG. 6 FIG. 7 FIG. 8

FIGS. 6 TO 8. TYPES OF STATOR SLOTS

copper circuit to carry current and the iron circuit to carry magnetic lines of force.

The amount of current, or flux, that is being carried by a given cross-section of copper or iron determines the heating of the motor. It may be assumed that in a normal motor operating under the conditions for which it was designed, there is a reasonable current flowing in the copper and a reasonable flux in the iron, which the designer believes will give the most satisfactory operating results. Therefore, if changes are to be made in the speed, phase, frequency and voltage at which the machine is to operate, the winding must be reconnected so as to have approximately the same number of magnetic lines per unit cross-section of iron and the same current density in the copper that existed before the change was made in the motor. This statement is true over a wide range of conditions, and would be true universally if it were not for the fact that the high-speed machine will generally run cooler than the same machine operated at low speed with the same current density in the copper and number of magnetic lines per unit cross-section of iron, because of the larger amount of air that the high-speed machine will force through its parts. For this reason it is generally true that the capacity of a motor may increase in the same proportion as the speed when the speed is being increased, but may decrease somewhat faster than the speed is being reduced. As a concrete example of this, it may be stated that a 75-hp. motor operating at 450 r.p.m. may be made to develop 150 hp. at 900 r.p.m., assuming that the mechanical design will stand the stresses due to the increased speed; but conversely, a motor originally designed for 150 hp.. at 900 r.p.m., when cut down to 450 r.p.m. might not be able to develop more than 65 hp., on account of reduced ventilation.

It is the object of these articles to describe briefly the questions that must be considered in determining whether the characteristics of a motor may be changed in the manner desired; secondly, what the effect would be on the winding of the motor with respect to the number of turns in the coil and the mechanical parts of the coil; and thirdly, by what simple mechanical means such as reconnection, if possible, that desired change may be accomplished.

There are certain fundamental mechanical relations that govern all motors whether alternating or direct current. The idea given in the foregoing of the reaction of the electric current upon a magnetic field concerns the production of a mechanical pull tending to rotate the movable member of the motor. This pull is usually expressed in pounds at one foot radius. This in turn is expressed in horsepower when multiplied by the r.p.m. and by π and divided by 33,000, and may be expressed by the equation:

$$Hp. = \frac{torque \times r.p.m. \times 2\pi}{33{,}000} = \frac{torque \times r.p.m.}{5{,}252}$$

from which

$$Torque = \frac{hp. \times 5{,}252}{r.p.m.}$$

Since the current in the copper and the flux in the iron are to be held approximately constant whatever change may be made in the motor winding, it follows that the torque will be kept constant and the horsepower will vary with the speed. In other words, if the copper and iron are carrying the same current and flux at all times, twice the horsepower will be developed at twice the speed or approximately one-half the horsepower at one-half the speed.

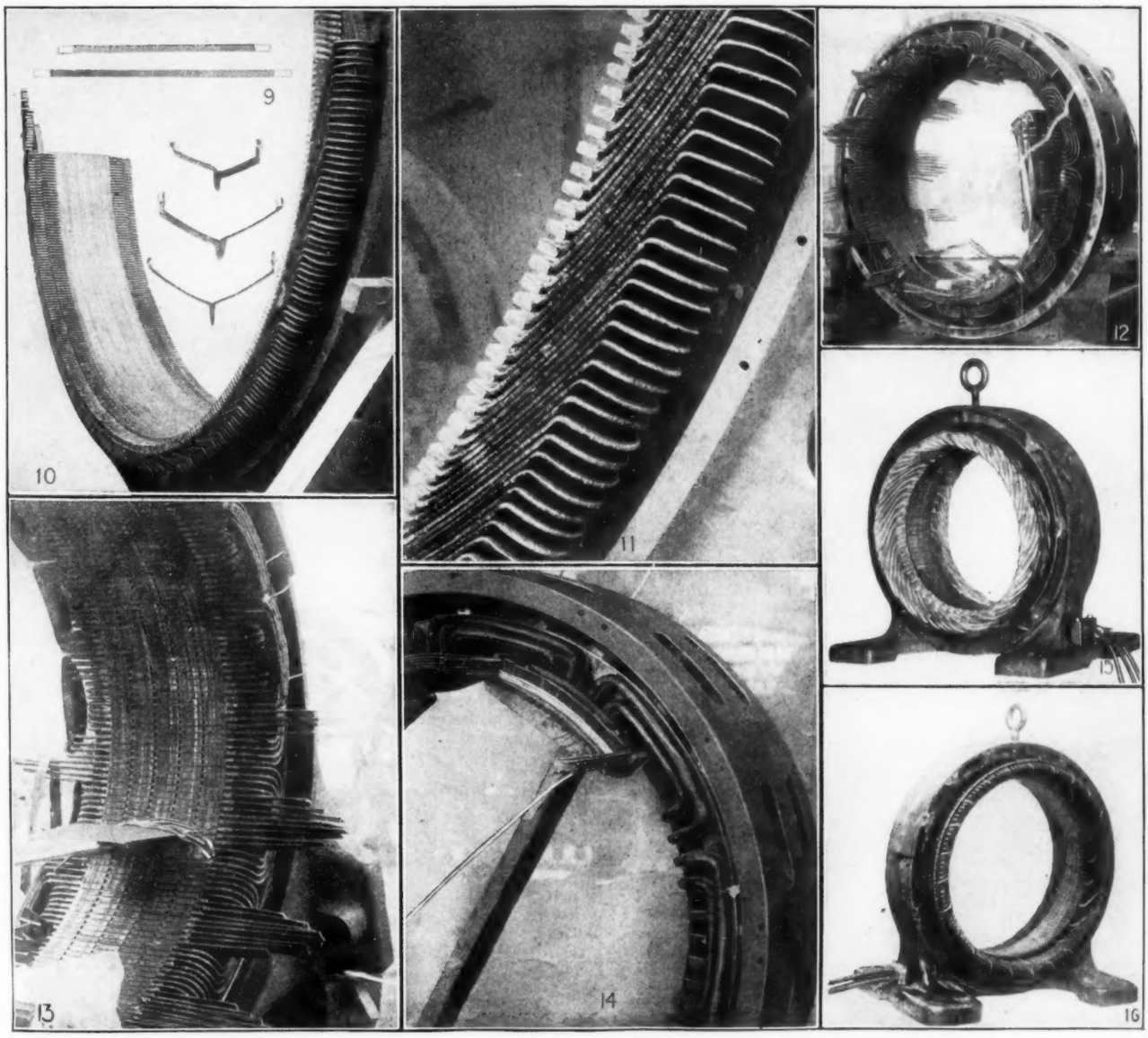
It is essential, in getting a clear conception of the motor, either for purposes of making changes or for other reasons, that a plain distinction be made between torque and horsepower. It is the function of a motor to produce torque, or turning effort. It is incidental that when the same force is allowed to rotate at one speed or another, a different horsepower is produced. For this reason it is incorrect to speak of a motor and say "It required 20 hp. to start the load," because, when starting, the motor was generally at a standstill; therefore there was no rotation and hence no horsepower. The motor, however, was taking current and developing torque, and the correct expression would be the current taken at start was equivalent to the current taken by the motor when developing 20 hp. at full speed.

It is often possible to reconnect a motor and adapt it to new conditions leaving it entirely normal, and the

performance in all essential respects remains the same as before reconnection. Such changes, for example, are represented by connecting the polar groups of a winding in series for 440 volts and in parallel for 220 volts. These are referred to later as strictly legitimate changes.

A second class of changes leaves the performance in some respects unchanged and alters it in others. These may be represented by operating a motor in star on 440 volts, and in delta for 220 volts. In this case there is little change in efficiency or power factor; the starting and maximum torques, however, are only 75 per cent. of their original values. In such a case the advisability of the change depends entirely on the work that the motor is doing. If the torques at their altered values are sufficient to start and carry the driven load easily, there is no objection to operating the motor indefinitely as so reconnected, since the motor will not run any warmer than before and its efficiency and power factor may be better. Such changes are referred to later as possible changes.

A third class of changes leaves a motor operative in the sense of producing torque enough to do the work required, but so alters its performance as to heating, or efficiency, or power factor, or insulation, that it is undesirable to leave the motor operating indefinitely in such condition. Such changes are represented by taking a three-phase motor and reconnecting the coils as they stand for two-phase. This is equivalent to operating the three-phase motor at 125 per cent. normal voltage, and in addition, the coils, which should have extra insulation where the phases change, have only group insulation. The iron loss and heating may be increased to a dangerous degree and the power factor greatly decreased. Such changes should be used only in an emergency and the proper permanent changes made at as early a date as possible. These changes are classified as makeshifts or undesirable changes.



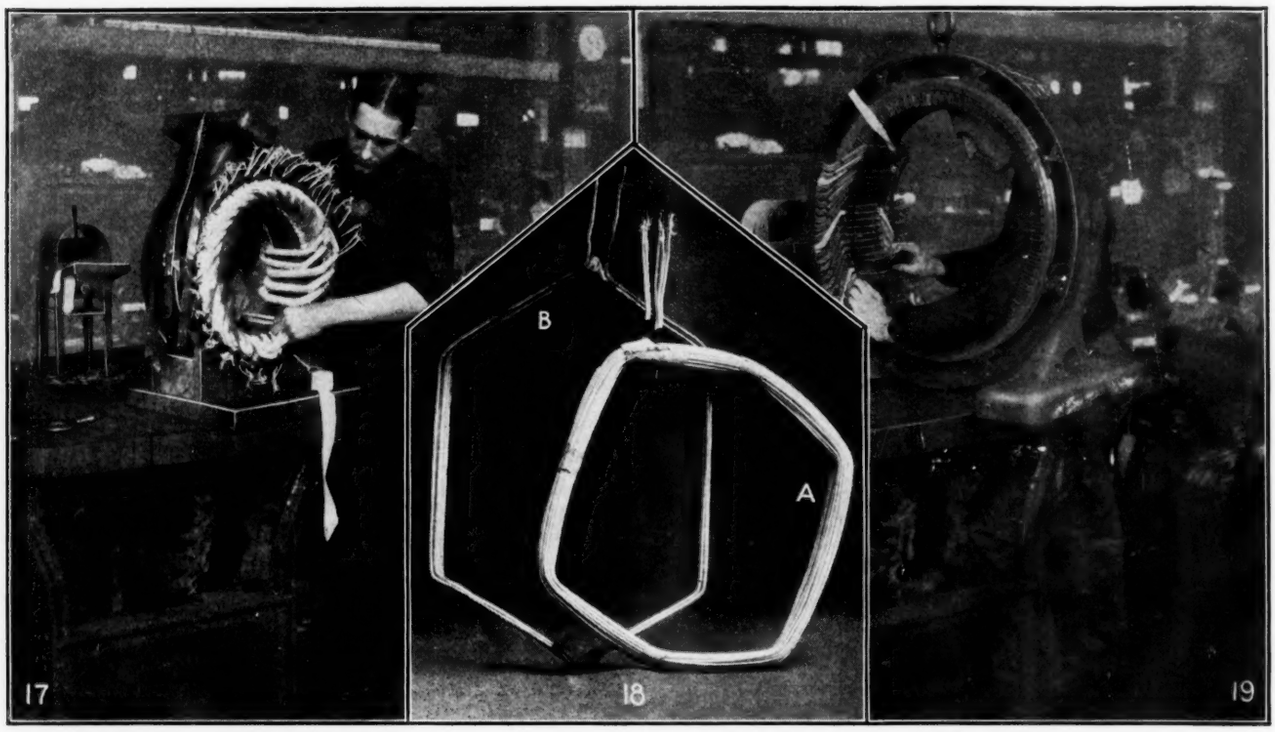
FIGS. 9 TO 16. TYPES OF INDUCTION MOTOR WINDINGS AND THE METHOD OF PLACING THEM IN THE SLOTS

The foregoing considerations are electrical or magnetic in their nature and lead up to considerations of a mechanical nature presented by the physical form of the windings themselves.

After a designing engineer has determined how many turns are required in the winding which he is calculating, the largest single factor which decides the form

of windings to be used is the mechanical form of the slots; that is, whether they are open, Fig. 6, or semiclosed, as in Figs. 7 and 8, and the width of the opening if they are semiclosed. The factor of next importance is whether the winding is on the rotor or on the stator.

The question of open versus semiclosed slots has outlasted many controversies and is still open to argument.



FIGS. 17 TO 19. WINDING SEMICLOSED-SLOT STATORS AND THE TYPE OF COILS USED

It is enough to say that, other things being equal, the designing engineer favors semiclosed slots. Slots of this type usually give the highest performance and the maximum efficiency in the use of material. The repair man

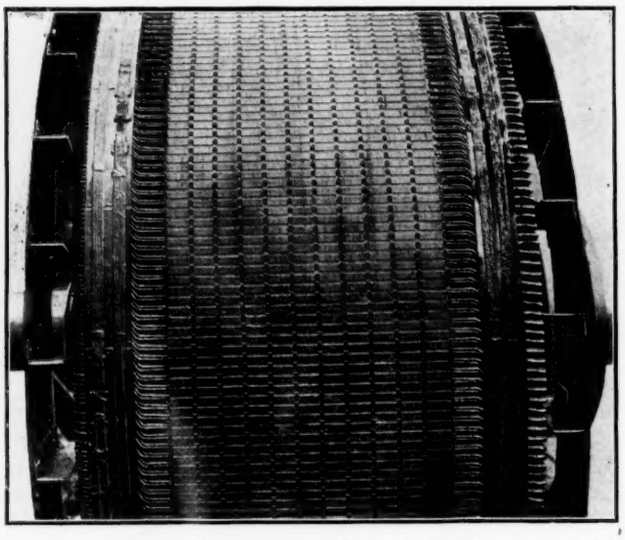


FIG. 20. WITH SEMICLOSED SLOTS AS IN FIG. 8, WOUND WITH FOUR COILS PER SLOT

prefers open slots on account of the greater accessibility of the windings and the consequent ease of repair. These factors will always remain somewhat divergent and must be adjusted to suit the times and the local conditions.

The reason why a machine cannot be built with as good a performance or as economically with open slots in both members is that, broadly, its capacity and excellence may be measured by the square inches of laminated-iron surface on the rotor periphery or in the bore of the stator core. Since the slot openings subtract directly from this useful surface, it is desirable to make them as small as possible. If the slot is made wide open, it subtracts the maximum amount from this useful working surface, hence the core must be made longer axially or the rotor increased in diameter to bring back the useful working surface to somewhere near the value it would have if entirely inclosed or if semiclosed slots were used. This problem is of more interest to the designer than to the repair man, but is mentioned to explain the use of a mechanical construction that is apparently undesirable from an operating standpoint.

The types of windings adapted to semiclosed slots and most generally employed are:

1. Straight bars with involute end connectors.

2. Pushed-through coils. In this type the coils are formed in a U-shape and pushed through two slots at once in a direction parallel to the shaft. After the coil is in place, the separate wires are bent around and connected together at the other side of the core.

3. Hand-wound or threaded coils. In this construction each coil is formed in place in the machine itself, from a single piece of wire, by the process of passing the wire through the length of one slot, bending it around a wooden former to make a suitable end and threading it back through another slot and repeating until the coil is complete with the desired number of turns. When completed, it resembles the pushed-through coil.

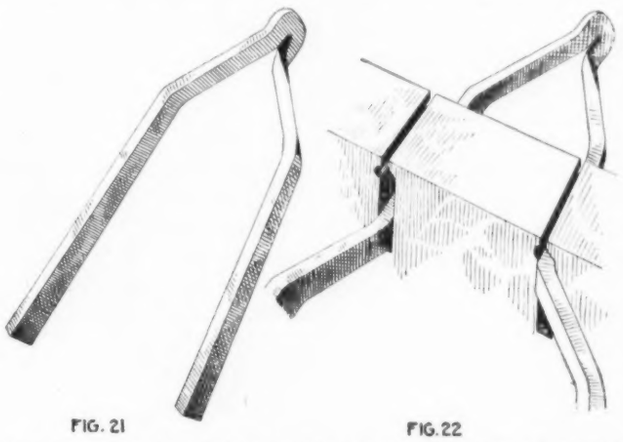
4. Fed-in, or dropped-in coils. In this type the coil is formed complete into a so-called diamond shape and then the turns are fed one at a time through the opening at the top of the slot.

The first of these types, bar and end connecter, has been widely used for both stators and rotors. The bars and connectors are shown in Fig. 9, and a typical assembled winding in Figs. 10 and 11. This winding gave excellent satisfaction, the only real criticism, from a mechanical standpoint, being that it was difficult to brace the coil ends mechanically owing to their form and relation to other parts. It has been almost abandoned on modern machines for the reason that it limited the winding to one conductor or two conductors per slot, and also because modern practice has demonstrated that the use of single very heavy conductors gives rise to additional copper losses which are not present when several smaller conductors in parallel are used to carry the same current. Examples of the different methods of connecting up such windings will be given in a later article of this series.

The second type, or pushed-through winding, is illustrated in Figs. 12 and 13. It will be observed that the labor of bending the coil ends and soldering each turn separately was considerable. This construction required somewhat more copper than the hand-wound type, but had the advantage that it could be better insulated. It has practically become obsolete in this country for induction motors, owing to the difficulty of making repairs.

The third type, or hand-wound, is illustrated in Fig. 14. It requires greater skill than any of the other types shown and somewhat more space in the slot than the pushed-through, and great care has to be used to avoid skinning the wire in winding. It has an advantage over the pushed-through winding in having no soldered joint anywhere throughout the entire length of the coil. Both the pushed-through and hand-wound types require considerably more handwork than other types and are consequently better fitted for use abroad, where hand labor is cheaper than in this country. For this reason these types of windings are still very generally used in Europe, but are practically superseded by other forms in the United States.

The fourth type, or fed-in coils, is illustrated in Figs. 15 and 16 and is used almost universally for the stators of motors up to 15 and 20 hp., at voltages of 550 and under. It has been widely employed as a stator winding in larger capacities, but the present-day tendency is to confine its use to smaller ratings and make use of open slots on the stator above this classification. It has still a considerable field as a rotor winding where the mechanical forces acting on the winding make desirable the use of a semiclosed slot with overhanging tooth tips which give greater support to the coils than is possible with open slots with wedges or bands. This type of winding is employed in two forms: First, as shown in Fig. 17, the coil for which is shown at *A*, Fig. 18; and second, as shown in Fig. 19, with the corresponding coil at *B*, Fig. 18. In the first of these forms there is but one coil per slot and the shape of the ends of the coils



FIGS. 21 AND 22. STRAP COIL BEFORE AND AFTER BEING PLACED IN A SEMICLOSED-SLOT CORE

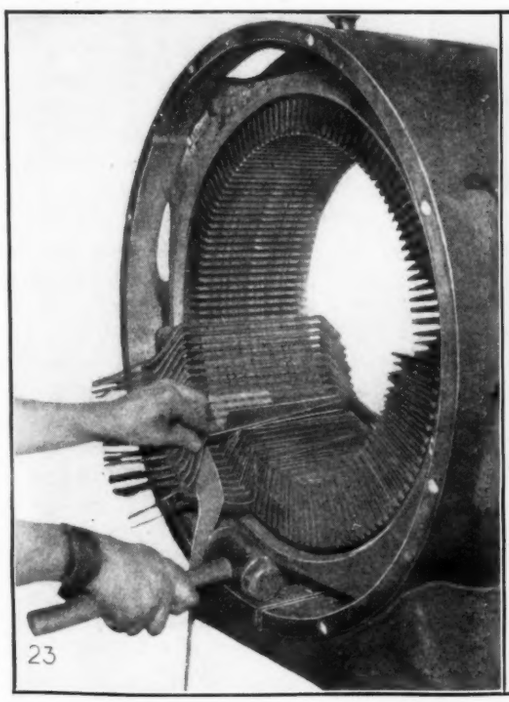


FIG. 23. WINDING DIAMOND-SHAPED COILS IN OPEN-SLOT STATOR

FIG. 24. DIAMOND-SHAPED COIL

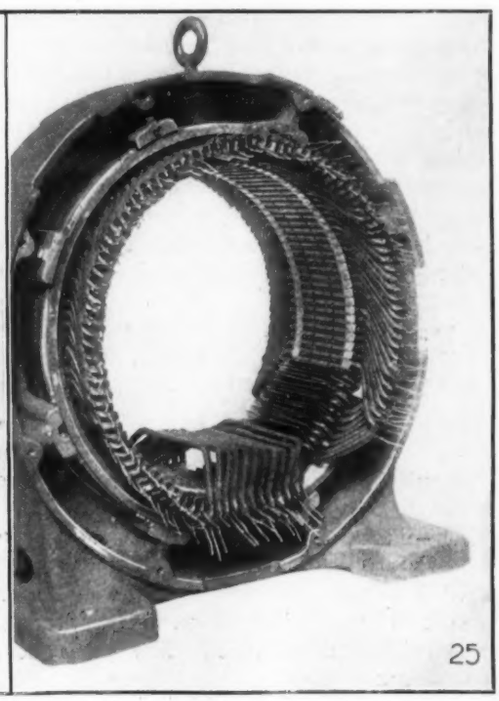


FIG. 25. SHOWS HOW LAST-POLE GROUP IS PUT IN THE SLOTS

is controlled largely by the winder as he puts them in place. In the second form there are two coils per slot, which have a definite and final form before being placed in the core and which resemble exactly, when completed, the well-known diamond-shaped coils wound into open slots. The first of these forms is suited to small and the second to larger machines. A modification of the second form makes use of a slot shaped as in Fig. 8 and is shown in place in Fig. 20. Each coil is completely insulated from ground and inserted in the slot as a unit, so that it might be considered as a combination of the coils from two adjacent open slots brought together and securely held by the overhanging tooth tip, which leaves an opening large enough for the passage of one complete coil while winding. It is considered one of the most satisfactory forms for use on the rotating part of machines up to the largest capacity. A similar winding has been made by forming the coil of one or two straps bent on one end only, as shown in Fig. 21, and insulating it. The straight sides of this coil are then pushed through two partly closed slots in an axial direction, and the two ends are bent to the proper form to connect with other coils, as shown in Fig. 22. This makes a good mechanical job, but is rather difficult to repair owing to the fact that several straps must be straightened out to get at the damaged coil.

With open slots, as illustrated in Fig. 6, the most popular and widely used form of winding is that shown in Figs. 23 and 25, for which the coil is shown in Fig. 24. This is the well-known diamond coil, so-called from its shape, and is entirely formed and insulated before placing in the slots. It is also the simplest and easiest coil to wind and is used by designers wherever the conditions permit. The greater number of typical connection diagrams shown in this series of articles has reference to windings of this general type, since they lend themselves so readily to changes of arrangement and various reconnections.

There have been many other modifications of coils or windings employed with both open and closed slots in making special machines or where unusual conditions justified their use, but the forms described cover the great majority of machines found in use today.

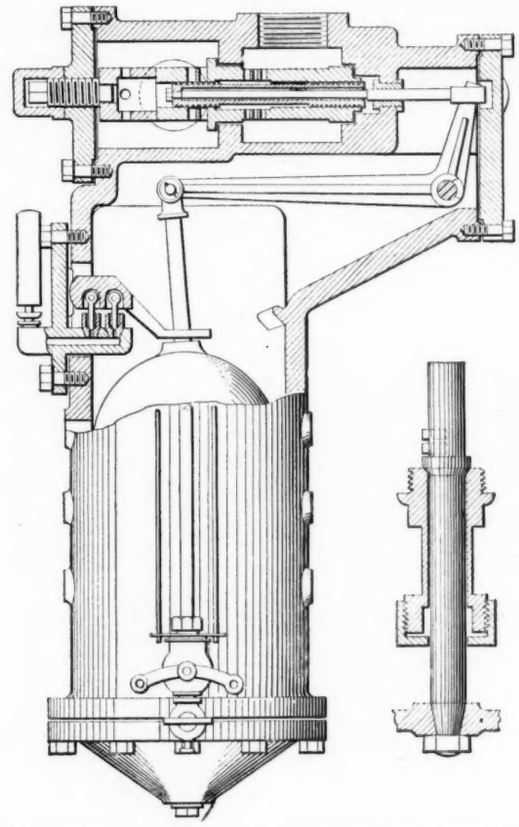
Ray Improved Continuous-Flow Feed-Water Regulator

The principle employed in the improved continuous-flow feed-water regulator made by the Ray Manufacturing Co., Louisville, Ky., is the same as that governing the construction of the earlier type described on page 312 of the Sept. 1, 1914, issue of *Power*. It consists of a balanced valve operated by a float, the feed water being admitted to the valve at its center and discharged at one end. The valve is designed to have the water passing through it in a continuous flow proportional to the evaporation.

A high- and low-alarm whistle is operated by the float that operates the regulating valve, by having two contact points on the float rod to engage the whistle lever. The lever is counterbalanced so that it holds the whistle valve closed when the pressure is off the boiler.

Regarding the improvements, the valve bushing, which was originally pressed into the valve-chamber head, is now made loose in the head and is held in place by a jackscrew, gaskets at the end preventing the passing of water except through the ports in the bushing and through the valve. The valve bushing now serves the double purpose of a valve cylinder and a strainer.

The admission ports are small drilled holes which will not admit any foreign matter that would interfere with the operation of the valve. Around the strainer at this point is an annular chamber which would take care of quite an accumulation of foreign matter before it would need attention. The improved regulator is equipped with a device so that the high- and low-water alarm whistle can be made to blow regardless of the height of water in the column. This is accomplished by extending the



DETAILS OF VALVE AND FLOAT-GEAR CONSTRUCTION

bearing pin for the bell-crank to the outside through a stuffing-box; the pin has a bar handle on it. This bearing pin has a stop pin that works in a slot in the bell-crank. Under normal working conditions the bell-crank will not touch this stop pin, but when a test is to be made, the bearing pin is turned until it engages the bell-crank and the float and valve are made to move their full travel and the whistle to operate.

Governor Belts Will Break—If the one on your engine should break, will your engine stop? If you do not know this to be the case, see to the adjustment of the safety cams on the Corliss engine and to the automatic stops on other types of engines, and make sure that they are adjusted to operate. They are likely to get out of their proper position and should be examined at least once a week and tested.

A Cylindrical or Conical Efflux Tube, or ajutage, fitted to the aperture of a vessel through which a fluid is escaping, will increase the amount of efflux considerably over that of a plain orifice and in some cases falls but little short of its theoretical value $A \times \sqrt{2gh}$, or a tube whose length is from two to three times its diameter has been found to produce an efflux per second of about $0.82 \times A\sqrt{2gh}$, or 82 per cent. of the theoretical value.

Refrigerating Troubleman's Job

By E. W. Miller

SYNOPSIS—An elusive knock in the cylinder of a vertical double-acting twin-cylinder compressor of old design baffles the engineer, who calls in the troubleman. What the latter found is told by himself.

One day I got a hurry call from a brewery plant to come out and see if I could find out what was the trouble with one of the compressors. Arriving, I found the machine was one of the old-type double-acting vertical twin-cylinder units. It was shut down, but the chief obligingly started it for me and then left me to my own resources. He was evidently peeved about something. The compressor ran three-legged; that is, it would run three-quarters of a revolution at fairly even speed, and then it would make a lunge, like a man stepping into a hole in the sidewalk, for the last quarter.

Generally, when a machine acts this way, there is something wrong with the valves; they are either broken or stuck open. I found further indications of valve trouble after the machine had been running long enough for the frost to come back on the suction line. Three of the suction-valve cages frosted, but the fourth remained dry. When I got up on the machine deck and held my ear near the offending valve cage, I could plainly hear the gas blowing back through the valve.

Serious and Puzzling Symptoms

This was not all. At every revolution, from the moment the machine was started, there was a sharp, ringing, hammerlike knock shortly after one of the ammonia cranks had passed the center. This was on the up stroke and not on the compressor with the defective valve, but on the one where the valves were apparently working properly. When the machine was first started, I noticed a light pound just as the crank of the compressor with the defective valve passed the lower center. Soon this knock changed location and seemed to come when the crank passed the top center. The machine apparently was an outlaw and liable to do anything. The knock gradually increased in intensity until it became a healthy thump. I was almost certain that the piston was hitting the top of the cylinder, but what was puzzling me was that it had been knocking on the bottom when first started. The knock got so bad that I became nervous and slowed down the machine.

About this time the chief came back and in a little better humor, most likely because he saw that I was as badly at sea as he was. He informed me that the thump had started one night after the machine had first made one terrific pound, and the rest of the night it had pounded in passing over the bottom center. In the morning he had shut it down as soon as he came on duty. He backed out the piston rod a little thinking that it might be running too close to the bottom head. He shifted it sufficiently to change the knock to the top center. He changed it back a little and the pounding came on the bottom again. It looked as though there was not enough clearance, but when they had overhauled the machine the winter before there had been about $\frac{1}{16}$ in. clearance at each end. How it had disappeared was the problem. He had taken the piston out of the cylinder thinking there might be something in the cylinder that the piston was striking, but everything appeared to be clear. When he started the machine, the piston hit lightly on the bottom head at first and then it finally changed to the top. Evidently there was no clearance, and as soon as the piston rod warmed up and got longer, the knock changed from the bottom to the top head.

Trying To Locate the Knock

I asked him about the leaky valve, and he said he knew it was broken, but that he thought it would run the season. He had tried to get it out, but concluded he could not do so without breaking up the whole valve cage.

To add to his troubles the other side of the compressor had started to knock that morning. This was the sharp ringing knock I have mentioned. He had taken out every valve in this compressor, also the top head, without finding anything wrong. It was peculiar that the knock happened after the piston rod had started upward about an inch or more. If the knock had come when the crank was at the lowest point one would have supposed that the piston was hitting the bottom head, but this was evidently not the case. The machine began to get pretty hot, and the pounding in the one cylinder was indeed dangerous.

We pumped down and took the head off. There was nothing wrong on top of the piston except that we could see some points where it had been striking the head. I decided to have a look at the bottom of the cylinder, and we got busy and unscrewed the piston and pulled it out. Apparently there was nothing wrong here. Dropping a light down in the cylinder to have a good look around I noticed a bright spot at one point on the bottom head. This led to an examination of the under side of the piston, which was left hanging in the tackle. Imagine our astonishment when we found part of a valve stem embedded in the under side of the piston. The piston was of the cored type and the valve stem had been practically pressed through the bottom wall.

Repair to the Piston

This explained the cause of the heavy pound the night the trouble first started and also why it was impossible to adjust the clearance so that the piston would not hit the head. To remedy the trouble without delay, we chipped the valve stem down even with the surface of the piston with cold chisels and then drilled holes through the stem and piston to the other side and put in rivets to make sure that the piece of stem would not drop out and start more trouble.

It was evident that the stem was part of the valve that was not working properly, and I decided to go after this next. A setscrew had backed out of the valve cage and up against the side of the valve chamber, holding it solid. As there was only about $\frac{1}{16}$ in. space in which to get at it, a wrench was out of the question, but several hacksaw blades cut it off. The chief was feeling even better now that we were accomplishing something.

The machine ran steadily and the thump was gone from the one cylinder. The ringing knock remained in the other cylinder, however, and it seemed impossible to locate it. Soon the rod on this compressor got so hot we could smell the burning packing. The chief told me that he had been having considerable trouble with the packing on this compressor ever since the season started. The other side had not given trouble while this one had to be repacked every two or three weeks. The oiler loosened the gland, and the knock increased in intensity. I told him to tighten it up as much as he could to see what would happen. The knock nearly stopped.

There was evidently something wrong in the stuffing-box, and we shut down, pumped the machine out again and pulled the packing out of the stuffing-box. When we got to the oil lantern, we were dumbfounded to find that there was not a shred of packing in the box above it. The most surprising thing was that a ring of home-made metallic packing had disappeared also. The lantern had been babbitt-lined and this had partly melted. When it had cooled some of the packing had stuck in it and the result was that the packing had wedged the lantern on the rod. This is what had made the rod run hot and also what had caused the ringing knock in the machine. When the packing was all gone the lantern, being wedged on the rod, struck the bottom of the stuffing-box at every stroke.

Inspection of the stuffing-box showed where the packing had gone. There was probably an eighth of an inch clearance between the piston rod and the hole at the bottom of the stuffing-box. The rod had been turned during the winter, and no provision had been made in the stuffing-box to make up for the reduced size of the rod. The result was that the packing squeezed out between the hole in the stuffing-box and the rod. Of course it also wedged in here during the process and caused the rod to run hot.

Steam-Engine Troubles—Governors

By H. Hamkens

SYNOPSIS—Eighth of a series of articles on the subject of steam-engine troubles. This one treats of flyball and inertia governors, tells what features a good governor must have, describes many forms of troubles and gives easily understood directions for correcting them.

The governor of a Corliss engine may be regarded as a permanent watchman, overlooking the performance of the apparatus with an observant eye. If more power is required, it drops, apparently on its own account, and lets the engine take more steam; and as the load decreases, it rises and reduces the amount of steam to suit. We owe this device to the genius of James Watt. The old pendulum, or flyball, governor still holds its own. The principle on which its action is based is so simple and effective that it is still widely used. A few changes have been made to adapt it to various conditions. Engines designed by Watt ran slowly and so did the governors. As engine speeds increased, the governors were made to run faster and their size diminished.

Fig. 102 shows the customary form of flyball governor in use on many Corliss engines. The speed of these governors ranges from 50 to 60 r.p.m. Flyballs are from 6 to 9 in. diameter. The lift of the governor sleeve is from 3 to 4 in., with an additional drop of 1¼ in. to the safety stop. As the regulation of this governor is not close, it should be used only on engines for sawmills, stoneyards, machine shops, flour mills and factories with belt or rope transmission, where the friction load is a large percentage of the total and where close regulation is not essential. One of the troublesome features of the design is the collar *A* which supports the weight of the governor. If not always well oiled it will wear into its seat and change the height of the governor and the cutoff of the valve gear. It may also cause the gears to mesh too deep and break the teeth. A ball bearing is sometimes placed under the collar, but this does not improve matters if the lubrication is insufficient.

To avoid the trouble with a collar, it is advisable to extend the spindle below the gear box and use a step bearing, as shown in Fig. 103. The end of the spindle should be hardened and ground. Two plates are to be placed under the spindle, the upper one of phosphor bronze and the lower of steel; each should have a hole in the center and oil grooves on both sides. The steel plate should rest on the end of a large setscrew, which will permit the governor to be adjusted for height and also to take up wear in the step. The setscrew should be secured by a check nut. The step bearing can be kept well oiled, since oil from the governor spindle and sleeve will drain into the bottom of the gear box; there is no danger of its running dry. It may be cleaned from time to time by pouring kerosene into it and draining it through a pipe-plug or small pet-cock near the bottom.

For engines that require closer regulation, run at a higher speed, and especially for compounds, a weighted governor like that shown in Fig. 104 is much used. By increasing weight and speed the governor is made more powerful and less liable to be affected by friction. The weight must not revolve with the spindle, it should simply rest on the sleeve. The hole should be at least ⅛ in. larger than the spindle to prevent contact causing friction. Everything about the sleeve and the joints must be free and well-oiled, otherwise the governor will stick in some places and make the engine race.

Governors that are actuated by centrifugal force and weights are slow in action; to attain greater sensitiveness and closer regulation, spring governors are used on many modern engines. Fig. 105 shows an example, with a compression spring in the top of the governor, adjustable by two nuts on the sleeve. The balls are made either in one piece with the level or separate, as shown in the detail. If separate, they may be adjusted for height and accurate balance. Spring governors are simple in their conception, but they should not be experimented with except by competent mechanics. One case is known where an engineer cut a couple of inches off the spring to make the engine run faster. He did not get exactly

what he had expected and telegraphed the builders that their governor was no good and that they should immediately send a man to fix it.

The rollers at one end of the arms which actuate the sleeve have a tendency to wear flat on the circumference and grooves in the lugs of the sleeve, either of which will materially affect the reliability of the governor. The pins in the arms are also subject to considerable wear on account of the heavy pressure exerted by the spring and the incessant oscillations of the balls. To obviate this defect, the governor shown in Fig. 106 has been designed. Instead of balls this has flat semicircular weights, each with a large hole in the center to receive a compression spring. The weights are supported by the arm by means of pins located in the same plane as their center of gravity. The centrifugal forces of the weights are directly opposed to the resisting forces of the springs, consequently there is no pressure due to either of these forces acting on the arms, and little wear on the pins. The springs can be adjusted, and the speed of the governor and engine varied between certain limits by tightening or loosening the nut *M*, increasing or decreasing the pressure on the springs. On account of the high speed at which these governors run, it is almost impossible to keep the joints lubricated; a new supply of oil can be put on only when the governor is at rest, and this is soon thrown off when it is up to speed; there is no way of oiling the joints as long as it is in motion.

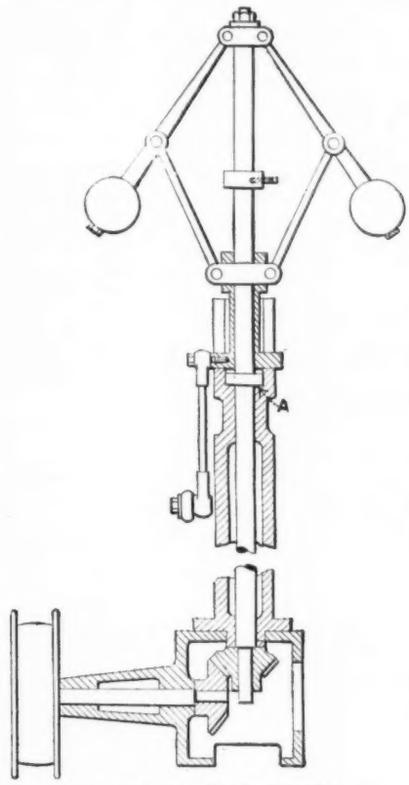


FIG. 102. COMMON FLYBALL GOVERNOR

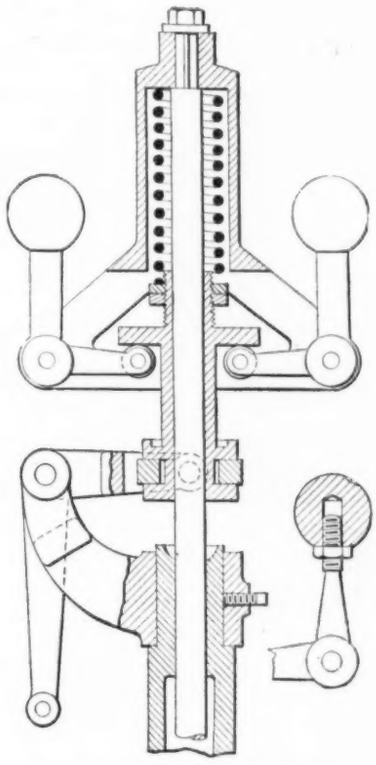


FIG. 105. FLYBALL SPRING LOADED GOVERNOR

This deficiency has been overcome in the design shown in Fig. 107. The weights and springs are arranged as shown in Fig. 105, but the arms act on a sleeve connected to the collar by two studs passing, closely fitted, through holes in the hub of the casing, which extends well up into the inside and keeps the oil from running out. The weights are supported by rollers which run on planed surfaces of the casing. All parts in the lower half of the casing work in a bath of oil. The oiling of the upper pins, rollers and slides is effected through the cap on top while the governor is in motion. This governor is dustproof and it cannot throw off any oil except that which works its way out through the two holes around the pins in the hub. For compactness and sensitiveness these inclosed-spring governors are about all that can be desired. The two springs are a disadvantage; unless they are evenly matched the governor is liable to be out of balance. Compression springs have a tendency to buckle if the ends are not truly square. It is advisable to pay attention to this before inserting the springs.

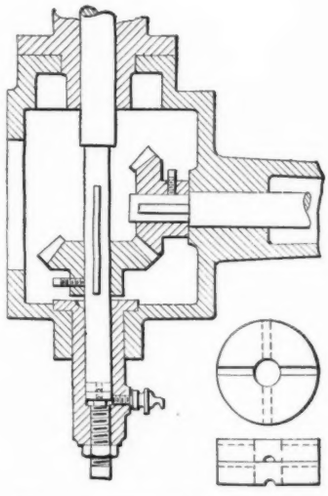


FIG. 103. STEP BEARING FOR FLYBALL GOVERNOR

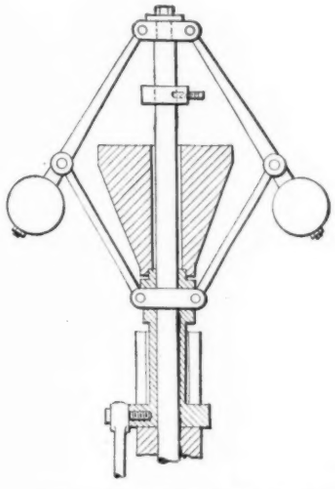


FIG. 104. WEIGHTED FLYBALL GOVERNOR

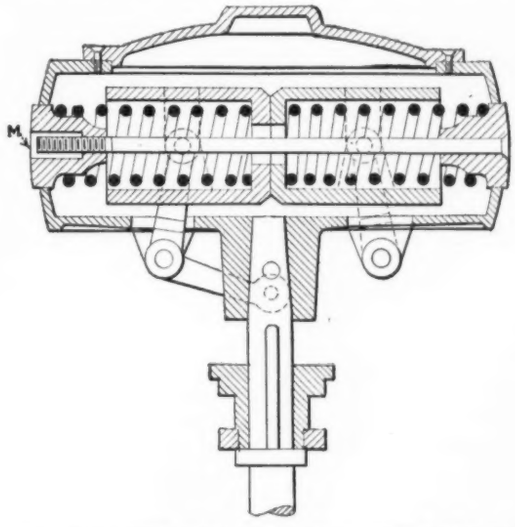


FIG. 106. THE WEAR IN THIS GOVERNOR IS SLIGHT COMPARED WITH THAT IN FIG. 105

For testing the springs platform scales can be arranged inexpensively in the following manner: Two iron bars 2 in. wide by 1 in. thick, each about 4 in. longer than the base of the scales, are placed as shown in Fig. 108. They should have holes drilled in the end for two ⅝-in. bolts with long threads and two nuts at each end to clamp the bars. The upper bar must be provided in the center with a long screw about ⅞ in. diameter. The spring to be tested is placed on the platform, resting on a casting with a projection for the spring to fit over, as shown in detail. A similar casting is placed on top of the spring except that this one has a countersunk hole drilled in the upper side into which the pointed end of the setscrew fits. With everything in place, the scales are balanced without putting any pressure on the spring; the reading on the beam represents the weight of the bars, rods, screws, etc., and the spring. If the length of the spring was measured when free, the deflection of the same caused by the weight of the bars, etc., can be noted. The setscrew should now be turned one revolution at a time and the pressure after each turn recorded. For a ⅞-in. screw it will take nine turns to compress the spring 1 in.; the difference between the first reading and the one after nine turns is called the stiffness of the spring, meaning, of course, that it takes that many pounds to compress it 1 in. The test must be continued for the full working range of the spring, after which the readings for each turn of the screw can be compared. For a good spring the increase in pressure for each turn must be uniform.

To obviate trouble arising from the use of two compression springs, the design shown in Fig. 109, using one tension spring, has been introduced. The speed can be adjusted by changing the tension of the spring. The arrangement of the weights is about the same as in Fig. 106, but there is no outside casing; everything is in plain view and can be watched. Roller bearings are provided for the pins in the weights as well as in the arms, reducing the friction to a minimum. The roller bearings retain the oil for a long time, so there is not much need for a fresh supply, and hardly any oil can be thrown. The governor spindle is supported in a step-bearing without any adjustment for wear, and the gear on the spindle is located above its mate, which is subject to the same objection as raised in regard to Fig. 102.

Another centrifugal-spring governor with one tension spring is illustrated in Fig. 110. In this design all the rotating parts are inclosed in a stationary casing, making it impossible for oil to be thrown on the engine and floor or on the generator, if the engine is direct-connected. The lubrication is effected by a small pump located at the lowest point near the step bearing. When the

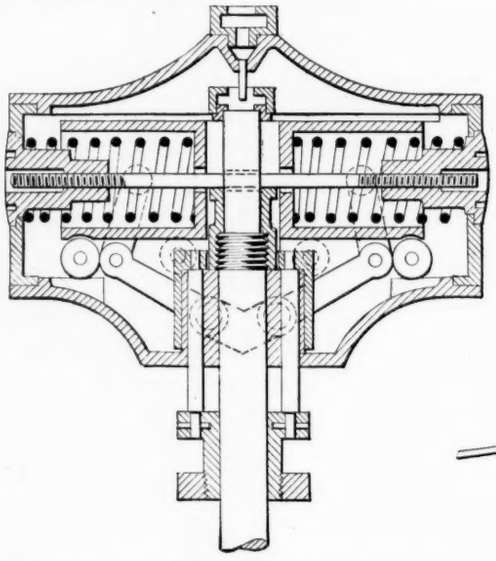


FIG. 107. THE WEARING PARTS RUN IN AN OIL BATH

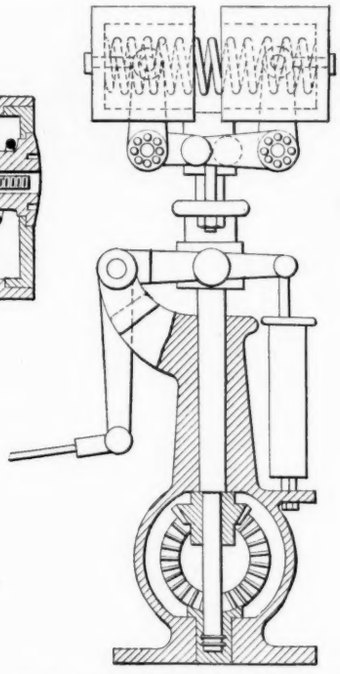


FIG. 109. THE GOVERNOR USES ONE SPRING, AND THAT IS IN TENSION

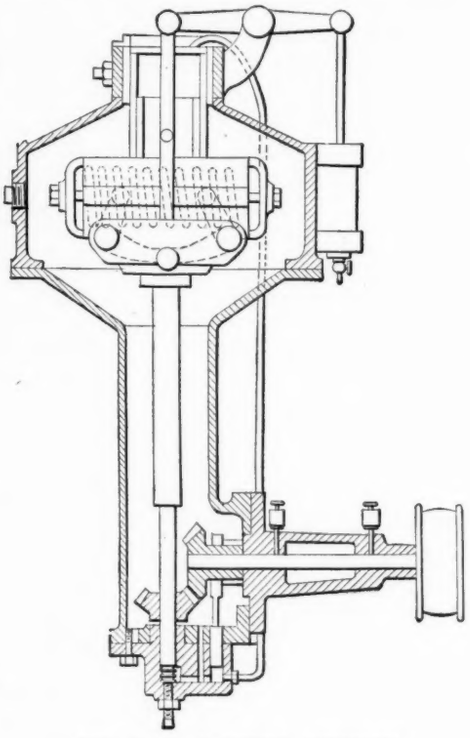


FIG. 110. ANOTHER TENSION SPRING GOVERNOR

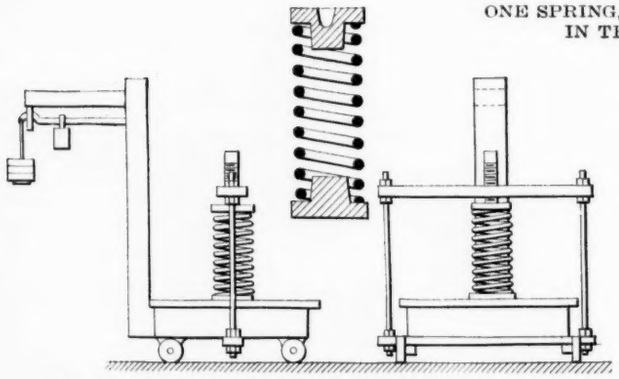


FIG. 108. TESTING SPRINGS ON PLATFORM SCALE

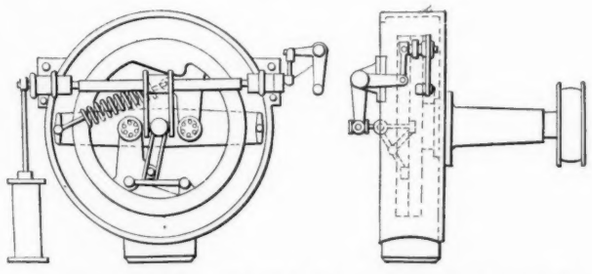


FIG. 111. A CLOSE-REGULATING INERTIA GOVERNOR

governor is running and the pump is in working order, an abundance of oil will be forced to the top of the casing and from there over the working parts. This way of oiling is of doubtful value, for if the pump gets out of order the governor will have to run without oil until somebody discovers the trouble. It would be far better to take the oil supply from a continuous gravity oiling system with a stream of oil running into the top of the governor.

Inertia influences the moving parts of a governor to a great extent. Its action in the flyball and centrifugal-spring types described is detrimental, as it either unduly

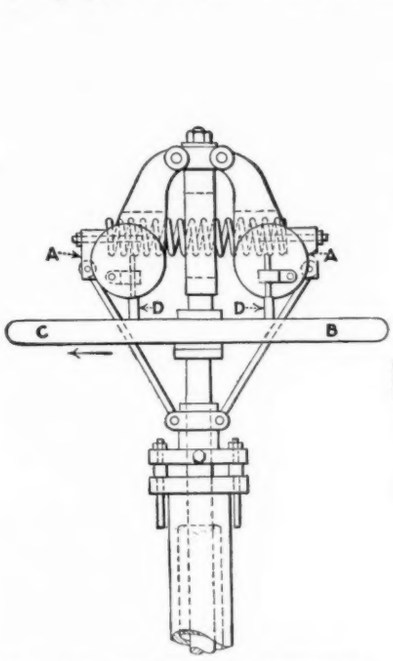


FIG. 112. COMBINATION CENTRIFUGAL AND INERTIA GOVERNOR

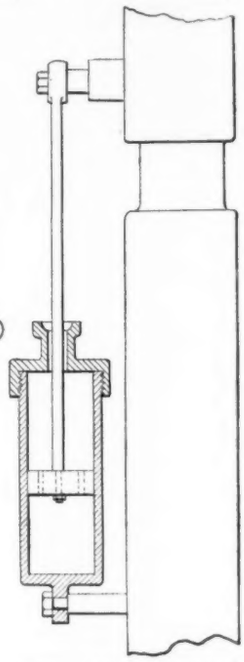


FIG. 112-A. NONADJUSTABLE OIL POT

retards or accelerates the motion of the balls and weights. In an appropriate design, however, it can be used to advantage. Fig. 111 shows an inertia governor that is in use on a number of engines, mostly direct-connected, noteworthy for close regulation on varying loads. In this design no gears are used for rotating the governor weights, also no vertical spindle or step bearing. The shaft on which the pulley is located also supports the governor weights; there are only two bearings on the shaft to be looked after. The weights are annular, pivoted on a double arm keyed to the shaft; a spiral tension spring holds them in position, and a link forms a connection between the two. As the governor begins to rotate, the centrifugal force tends to move the weights away from the center, thus actuating an arm which in turn rotates a shaft and thereby controls the governor rods and cutoff levers by a series of intermediate levers and links. The many levers, bell-cranks, pins, links, ball-and-knuckle joints on this governor are its weak points. The revolving parts are protected by a substantial case, which also serves as an oil shield. This type closely resembles shaft governors on high-speed engines and, like them, has the pivots for the weights, which are liable to give trouble on account of friction and excessive wear, even if provided with roller bearings.

The construction shown in Fig. 112 represents a combination of a centrifugal and an inertia governor, the weights *A* forming the centrifugal and the wheel the inertia part. A tension spring located on a plane with the center of gravity of the weights counteracts the centrifugal and inertia forces. The wheel *C* is supported on a collar of the governor spindle on which it can rotate. The vertical pins *D* connect the wheel with the weights *A* by brackets which slide up and down over the pins, according to the outward or inward motion of the weights. The action of the governor is as follows: With the engine running at normal speed the weights, wheel and spring will be in equilibrium, but when the engine slows down or speeds up, the governor spindle will follow suit. The weights will remain for an instant in their position, but the wheel, being free to move on the spindle, will continue at the former speed, and force the governor weights inward, thus admitting more steam to the cylinder when the engine slows down, and lag behind, with the opposite result, when it speeds up. The arrangement is ingenious and should give good results if everything is in working order, but here again one has to deal with a multiplicity of parts. The pins of the inertia wheel are liable to stick in the little brackets on the weights, or the wheel itself may bind on the spindle; in either event much trouble will follow. Complications on a governor should be avoided. All the parts of this one are exposed to view, but there is no provision made to prevent oil from being thrown off. If the load on an engine fluctuates considerably, the governor is liable to jump. Owing to the inertia of its parts it has a tendency to overtravel its true position on an instantaneous change

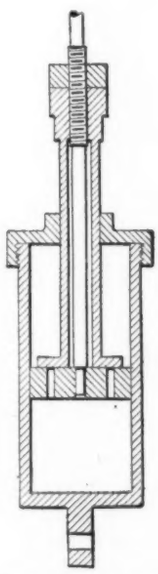


FIG. 113. ADJUSTABLE OIL POT

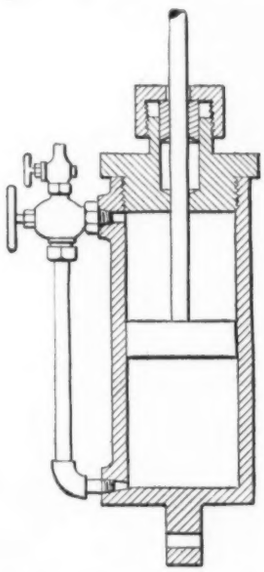


FIG. 114. THE OIL FLOW IS REGULATED BY THE VALVE

of load. This may become troublesome unless an oil pot be provided to prevent violent motion.

A simple oil pot in use on many engines is shown. To let the oil pass through, a number of holes are drilled in the piston, some of which may be plugged, according to the resistance required. The device is simple, but it has no outside adjustment. Fig. 113 shows the same style of pot which may be adjusted from the outside. The holes in the piston can be closed or opened to any degree desired by lowering or raising the sleeve. This makes a good oil pot.

Oil pots like that shown in Fig. 114, in which the flow of the oil is regulated by a valve in a pipe connection

on the outside, are likely to give trouble on account of air which may accumulate at the top. If there is any air in the pot, it will be alternately compressed and expanded and make the governor unsteady. There should be a little valve at the top to let out air and take in oil. A stuffing-box is needed for this pot, which of course increases the friction. The oil pot shown in Fig. 115 has some good features. As it is made of brass it is not subject to rust like pots made of cast iron. The piston has a groove turned on the outside with four holes at right angles to each other drilled toward the center. The piston rod is made of a piece of brass tubing riveted into the piston with two holes drilled through, one above the other, close to the piston. A small piston valve inside of the tube controls the passage of oil through these holes and is adjusted by a screw and check nut on the top of the tube. The object of the groove and the four holes in the piston is to cause the oil to circulate around the circumference and make it tight. The kind of oil to use in an oil pot must be learned by experience. It depends of course on the locality and on the season. That used in winter must be frostproof. Glycerin has been substituted in some cases, in others kerosene or a mixture of kerosene and machine oil. It depends on the prevailing conditions. All such devices must be watched to avoid gumming and sticking.

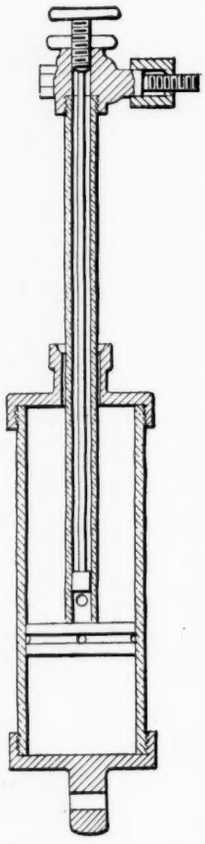


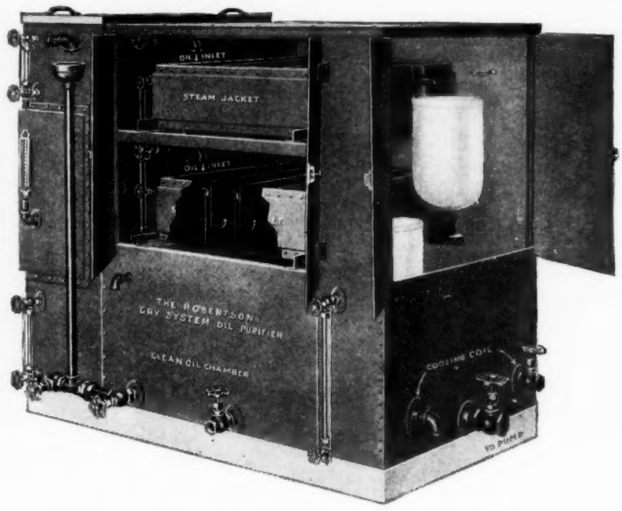
FIG. 115. BRASS OIL POT; NOTE RELIEF PORTS

[*The next article treats of forms of governor drive, of safety stops, and cutoff as influenced by the governor.*]

Robertson Dry-System Oil Purifier

When an oil filter is mentioned, one naturally thinks of a receptacle in which oil is filtered by passing through filtering materials and then made to pass up through a body of water. The Robertson dry-system oil purifier, however, does not make use of any of the usual filtering ingredients. It is well known that to thoroughly break up the oil globules, which hold the impurities in suspension, the application of heat is essential. This is the medium employed in this purifier, which is manufactured by the John F. Robertson Co., Pittsburgh, Penn.

Referring to the illustration, the incoming oil from the engine bearings first passes through a strainer that collects the heavier impurities. The oil then goes through a standpipe to the bottom settling chamber and in so doing is heat treated. By passing the incoming oil through the standpipe, it is prevented from coming in contact with the partly purified oil in the settling chamber until the sediment and condensation are deposited in the bottom. As the lighter oil rises, it passes into pipes leading to trays. Each pipe is fitted with a valve for regulating the flow of oil to the trays. A steam jacket surrounds each tray and is piped to drip all condensate forming in the jacket. All oil flowing into these trays receives an additional heat treatment in each compartment and flows over baffles until it reaches the filter bags, which are used to collect



ROBERTSON DRY SYSTEM OIL PURIFIER

particles too light for deposit. The oil then passes into the clean-oil chamber in the bottom of the purifier, where it is cooled by water circulating through a coiled pipe. The cooled, purified oil is drawn off through a pipe placed below the cold-water coil and pumped to an overhead tank or to the engine bearings.

Each purifying tray acts independently of the others and can be cleaned separately while the others are filtering. Oil in passing through the filter is subjected to at least seven heat treatments. The apparatus is easily cleaned, as it is made with doors opening into the purifying compartment and also into the filter-bag chamber.

The Storage, Handling and Filtering of Insulating Oils—Insulating oils are generally shipped either in the tank with the apparatus, in soldered tin cans or in steel drums provided with screw bungs, which are sealed before shipment. All oil in unsealed drums should be tested before using. Drums should always be placed on their sides for storage, never turned up on end, as such a position allows water to collect in the head around the bung. If at all possible, it is advisable to store drums in a closed room; if stored out of doors, protection from the weather should invariably be provided. Too great precaution cannot be taken to insure the thorough drying out of all apparatus before filling with oil, and during the actual transferring of the oil from the drums to the tank every care must be taken to prevent any moisture getting into either the oil or the apparatus. A drum of cold oil when taken into a warm room will invariably "sweat," and the resulting moisture on the outer surface may mix with the oil as the latter flows from the drum. Before breaking the seal, the drum should stand long enough to reach room temperature. All vessels used for transferring the oil should be carefully inspected to see that they are absolutely dry and free from metallic or carbonaceous particles. Immediately before placing the oil in the transformer or switch tanks, care must be taken to remove thoroughly any particles of foreign matter, scale, etc., that may have adhered to the interior of the drum too firmly to be removed by the washing and drying the drum receives at the oil refinery before filling, but have become loosened by the continual swashing of the oil during transit. This matter can be conveniently removed by using a funnel of large size with the top completely covered with two layers of any ordinary finely woven cotton cambric that has been thoroughly washed and dried to remove the sizing, and passing the oil through this as a filter. The oil will pass through more rapidly if slightly warm. The funnel may be made to discharge directly into the tank of the electrical apparatus; if not, the oil must not be returned to an empty drum unless the drum is known to be thoroughly clean and dry.

Steam Engineers' License Examination—IV

By H. F. Gauss

SYNOPSIS—A classification of steam engines followed by a simple explanation of the "D" slide valve, which embodies all fundamental elements of valve action. Lap, lead and angle of advance are explained, and their determination for a given set of conditions is demonstrated by means of the Zeuner diagram.

To fix in the mind the different types of steam engine some definite method of classification should be clearly understood. Classifications similar to the following appear in one of the books on steam engineering in the International Library of Technology:

1. Steam engines may be classified according to the place and kind of service for which they are intended, as stationary, locomotive and marine.

2. They may be classified according to the number of cylinders, as simplex, compound and tripple, etc.

3. They may be classified according to the type of valve used, as plain slide-valve, Corliss, poppet-valve, etc.

4. They may be classified according to the motion of the piston, as reciprocating or rotary and may be either horizontal, vertical or inclined, condensing or noncondensing, single-acting or double-acting.

The uniflow engine, has a long piston which covers and uncovers the exhaust-steam ports, located at the center of the cylinder. Originally the uniflow engine was essentially a condensing engine, but the noncondensing type is being developed and high economy is claimed for it.

Probably a clearer understanding of the different types of engines may be had from a study of the valve gears peculiar to each type. A classification of valve gears in common use is as follows: (1) Simple or fixed cutoff gear as commonly used with a slide valve; (2) variable cutoff gear (not automatic); (3) automatic variable gear; (4) Corliss or releasing valve gear; (5) radial valve-gears for either changing the point of cutoff or reversing; (6) reversing valves.

The simple "D" slide valve, while the most common, embodies all the fundamental elements of valve action, and a clear comprehension of its operation is necessary for the understanding of more complex valve gears. Definitions of the various terms applying to the proportions of the ordinary slide valve are as follows:

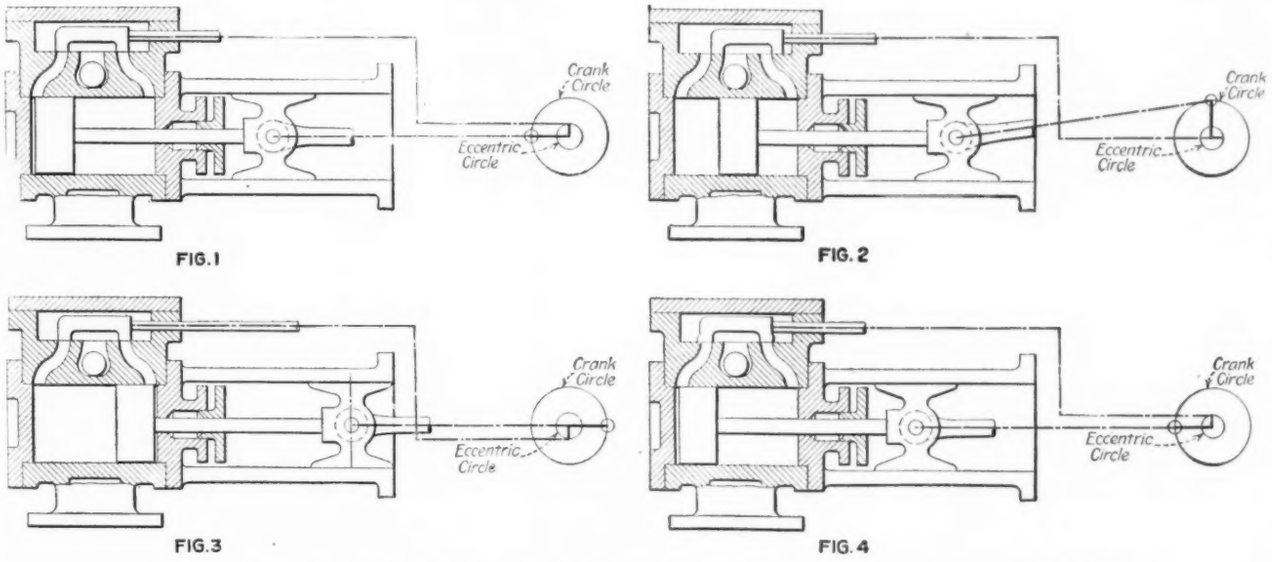
1. Outside lap is the amount by which the valve overlaps the outside edge of the port when the valve is in mid-position. For a direct valve this is called steam lap, for an indirect valve it is called exhaust lap.

2. Inside lap is the amount by which the inside edge of the port is covered by the valve when in mid-position. For a direct valve this is called exhaust lap, while for an indirect valve it is called steam lap.

3. Lead is the amount by which the valve uncovers the port at the beginning of the stroke. The lead to exhaust is generally greater than the lead to steam admission.

4. The angle of advance is the angle greater or less than 90 deg. by which the eccentric is ahead of the crank. When greater, the angle of advance is specified as positive; when less, as negative.

Probably no means will serve better to illustrate the necessity of these various properties of the slide valve than, first, a study of a slide-valve engine provided with a valve having neither steam nor exhaust lap and whose eccentric is exactly 90 deg. ahead of the crank; second, a study of a slide-valve engine whose valve has steam lap but no exhaust lap and whose eccentric is exactly 90 deg. ahead of the crank; third, a study of a slide-valve engine whose valve has both steam and exhaust lap and whose eccentric is 90 deg. plus an angle of advance ahead of the crank.



FIGS. 1 TO 4. POSITION OF VALVE, OF GIVEN PROPORTIONS, RELATIVE TO THE CRANK

Fig. 1. No lap; no lead; no angular advance; head-end center. Fig. 2—No lap; no lead; no angular advance; mid-stroke. Fig. 3—No lap; no lead; no angular advance; crank-end center. Fig. 4—Lap; no lead; no angular advance; head-end center

These three cases will be considered in order and illustrated by diagrams. Figs. 1, 2 and 3 are diagrams representing a slide-valve engine whose valve has neither steam nor exhaust lap and whose eccentric has no angular advance. Fig. 1 shows this engine on the head-end center. The eccentric is 90 deg. ahead of the crank, and the valve and port edges are line-and-line.

Fig. 2 shows the engine after having been revolved through a quarter of a revolution ahead. In this position the eccentric center is farthest to the right and consequently the valve is at its maximum displacement.

Fig. 3 shows the engine on the crank-end center after having been revolved through one-half revolution. The valve and port edges are again line-and-line, with the eccentric in its lower central position. Steam has been admitted to the head end of the cylinder throughout the entire stroke, and the crank end has been open to exhaust throughout the entire stroke, there having been neither cutoff nor compression. In the present line-and-line position, unless the valves and ports are very accurately made, live steam will blow through from the steam chest into the exhaust.

Figs. 4, 5 and 6 are diagrams representing a slide-valve engine identical with the first in all respects with the exception that steam lap has been added to the valve. Fig. 4 shows the engine on the head-end center. The exhaust edges of the port are line-and-line with the inside edges of the valve, while the steam edges of the port are covered by the steam lap added to the valve. The eccentric is 90 deg. ahead of the crank. Fig. 5 shows the engine after having been revolved through a quarter of a revolution. The steam port was opened during this portion of the revolution, and the eccentric center is in its position farthest to the right.

If Fig. 5 is compared with Fig. 2, it becomes evident that adding steam lap to the valve cuts down the maximum port opening, and if it is desired to maintain the same maximum port opening, the throw of the eccentric must be increased accordingly.

Fig. 6 shows the engine after having been revolved through one-half revolution. The eccentric has reached its lower central position, the steam ports are covered by the steam lap, and the exhaust ports are line-and-line with the edges of the valve. The head-end steam port closed during this second quarter of the revolution, causing cutoff to occur, after which the steam in the cylinder worked expansively up to the end of the stroke, when the exhaust port opened. The crank-end exhaust port remained open throughout the entire stroke and did not close in time to cause any compression except that due to the restriction of the port in closing.

An indicator diagram taken from engine No. 2 would theoretically be as shown in Fig. 7. The faults are evidently no compression, late admission, late cutoff and late release.

Figs. 8, 9 and 10 are diagrams representing a slide-valve engine identical with the first and second with the exceptions that a greater throw has been given the eccentric as well as an angular advance sufficient to give the valve a small amount of lead for both the steam and exhaust ports at the beginning of the stroke. Fig. 8 shows the engine on the head-end center. Notice the angle of advance and the lead. The head-end steam port was opened shortly before the engine reached the position shown, thus all the clearance spaces are filled with steam at the initial pressure. Fig. 9 shows the engine after having been turned over through a quarter of a revolution. This is no longer the position of maximum valve displacement. It may be seen that the eccentric has already started back and has passed its position of maximum displacement by an angle equal to the angle of advance.

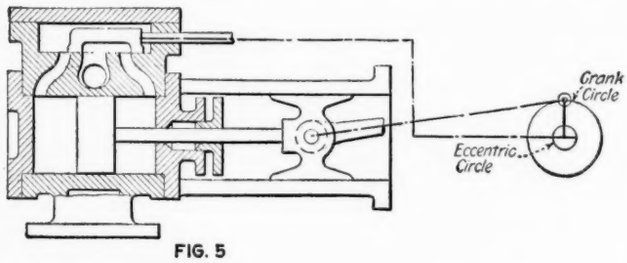


FIG. 5

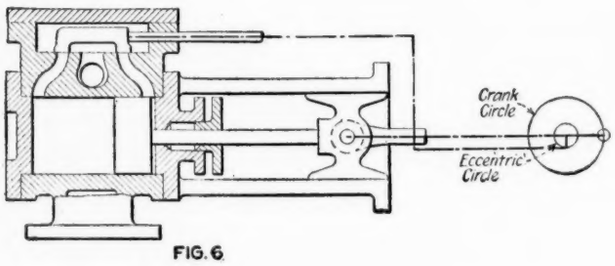


FIG. 6

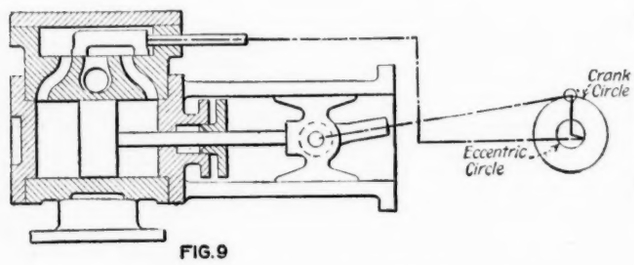


FIG. 9

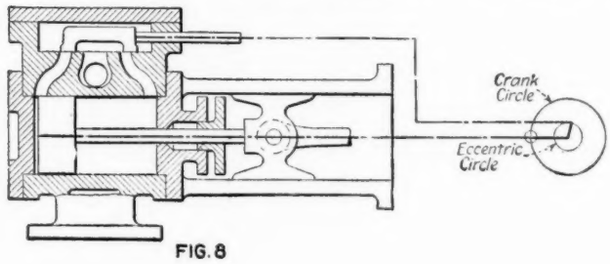


FIG. 8

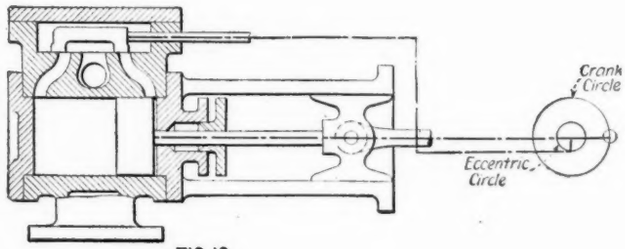


FIG. 10

FIGS. 5 TO 10. INFLUENCE OF ECCENTRIC POSITION ON RELATIVE VALVE MOVEMENT

Fig. 5—Lap; no lead; no angular advance; mid-stroke. Fig. 6—Lap; no lead; no angular advance; crank-end center. Fig. 8—Lap; lead; angular advance; head-end center. Fig. 9—Lap; lead; angular advance; mid-stroke. Fig. 10—Lap; lead; angular advance; crank-end center

In Fig. 10 the engine has turned through one-half revolution. It has reached the crank-end center. The crank-end steam valve is open by the lead; the head-end exhaust valve is also open by the exhaust lead. The head-end steam port was closed and cutoff occurred at some point during this second quarter of the revolution, while the crank-end exhaust port was closed and compression occurred at a point shortly before the position shown.

It should prove instructive to anyone interested and not thoroughly familiar with the action of the simple

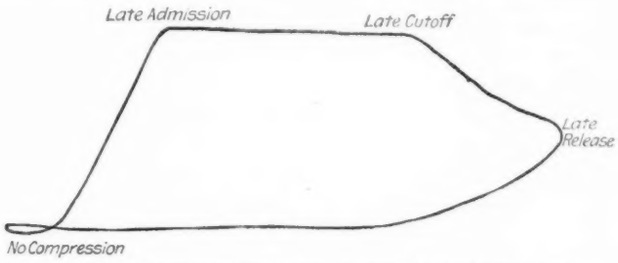


FIG. 7. THEORETICAL DIAGRAM SHOWING EFFECT OF STEAM LAP ONLY

slide valve to construct models of engines Nos. 1, 2 and 3 and study the relations between the crank and eccentric positions at all points in the stroke, especially at points of admission, cutoff, release and compression.

Steam should be admitted to the cylinder at a point before the dead-center sufficient to have all the clearance space filled with live steam at the initial pressure when the engine starts its return stroke. The actual amount of lead of course varies with different engines. With slide-valve engines it ranges from $\frac{1}{32}$ in. for 6-in. cylinders to $\frac{1}{4}$ in. for 48-in. cylinders.

With this type of valve it is impossible to secure a cutoff earlier than about seven-tenths stroke, because increasing the angular advance affects the other events of the stroke in such a way that there is a limit to the

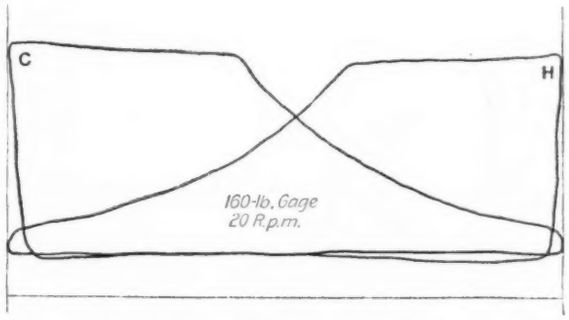


FIG. 11. DIAGRAMS FROM HIGH-PRESSURE CYLINDER OF TRIPLE-EXPANSION PUMPING ENGINE

amount of advance it is possible to give the eccentric. In general it can be stated that increasing the angle of advance causes all the events of the stroke to occur earlier.

The exhaust valve should open and release occur at such a point that an indicator diagram will show the drop in pressure from the end of the expansion line to the end of the stroke to be one-half the total drop from the end of the expansion line to the back-pressure line.

As to compression no fixed rules for the amount can be laid down. A cool, smooth-running engine and well-proportioned indicator diagrams are the best indications of proper compression. The following points have been mentioned in favor of high compression: (1) Compression serves as a cushion for the moving parts; (2) it does away with the shock of the entering steam at admission; (3) it causes the cylinder to be heated up and this reduces initial condensation; (4) it fills the

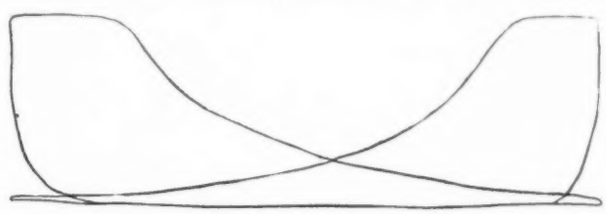


FIG. 12. DIAGRAMS FROM 100-HP. CORLISS ENGINE, 100 R.P.M.

clearance space with exhaust steam at high pressure, thus reducing the amount of live steam required.

It should be remembered, however, that there is a tendency for the trapped steam to condense after the pressure rises beyond a certain point, and that compression of the steam through a range approximating or greater than that through which it is expanded may cause part of the work done by the piston on the steam to be expended in warming the cylinder walls.

As a guide to the proper amount of compression for slide-valve engines, it can be said that the pressure in the cylinder at steam admission should be about 45 per cent. of the initial pressure above absolute. Slow-speed engines, say of 20 to 30 r.p.m., such as pumping engines, require very little compression. As the speed increases, the amount of compression necessarily increases, so that a good diagram for a high-speed engine is very different from a good diagram for a slow-speed engine.

Fig. 11 shows a diagram taken from the high-pressure cylinder of a triple-expansion pumping engine running at 20 r.p.m. and fitted with Corliss valve gear. Fig. 12 was taken from a 100-hp. Corliss engine running at 100 r.p.m.

The foregoing should give a clear idea of the purpose of lap, lead and angle of advance, but it gives no means

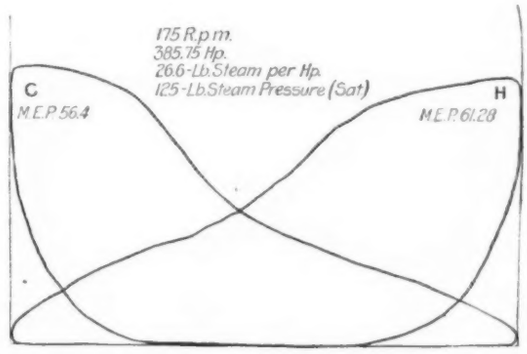


FIG. 13. DIAGRAMS FROM 250-KW. NONCONDENSING FOUR-VALVE ENGINE

of determining what the lap, lead and angle of advance should be in a given case, to satisfy certain conditions. The Zeuner valve diagram furnishes a simple means for solving valve problems and, with a little study, may be understood and applied by the average engineer.

To construct the Zeuner valve diagram for a specific case proceed as indicated in Fig. 14. With a common

center *o*, draw three circles—one *ab* with a radius equal to the steam lap; one *cd* with a radius equal to the exhaust lap, and one *ef* with a radius equal to the eccentricity of the eccentric. Draw the vertical and horizontal diameters and a diameter *gh* making an angle

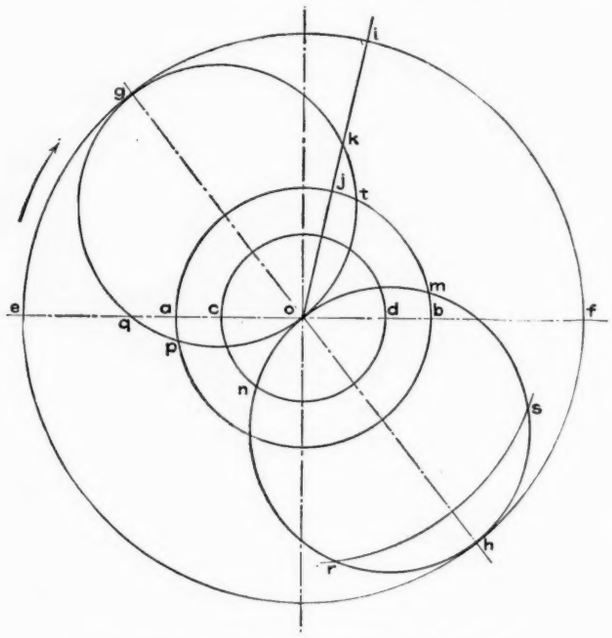


FIG. 14. THE ZEUNER-VALVE DIAGRAM

with the vertical equal to the angle of advance, laid off, however, on the side of the vertical opposite to the direction of rotation of the engine, the latter being in-

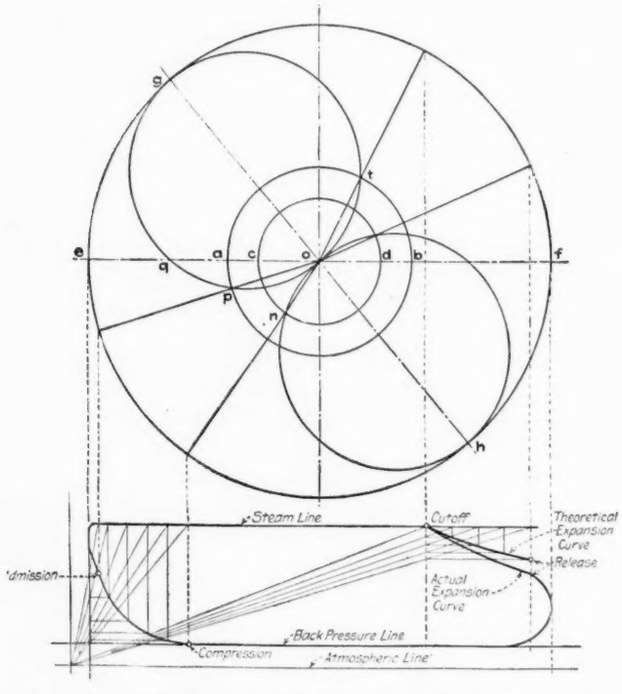


FIG. 15. ZEUNER DIAGRAM AND CORRESPONDING INDICATOR DIAGRAM

dicated by the arrow. Draw the circles *og* and *oh*. The construction of the diagram is such that, for any position of the crank—for example, *oi*—the amount the steam valve uncovers the port is given by the distance *jk* intercepted on *oi* between the circle *go* and the steam-lap circle *ab*. The circle *og* is the steam-displacement circle, and the circle *oh* is the exhaust-displacement circle.

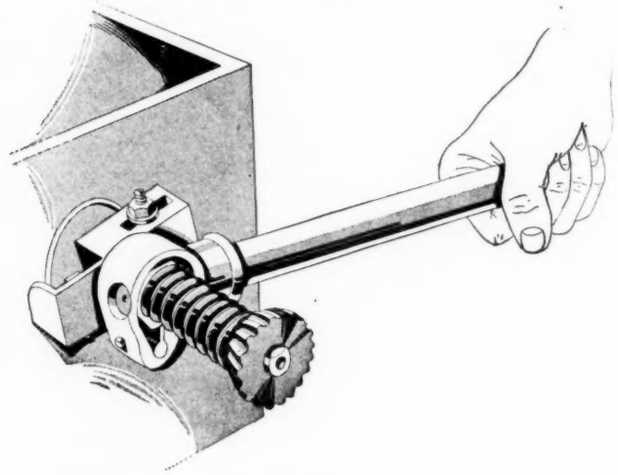
When the center line of the crank passes through *p*, the intersection of the steam-displacement circle with the steam-lap circle, the port opening is zero and the valve displacement is equal to the lap. The steam port is on the point of opening, hence *p* determines the crank position at admission. Likewise *t* determines the crank position at cutoff, *m* at release and *n* at compression. The points *m* and *n* are determined by the intersection of the exhaust-displacement circle with the exhaust-lap circle. The value of this diagram is at once apparent. For the opposite end of the cylinder, *oh* becomes the steam-displacement circle and *og* the exhaust-displacement circle.

There is generally considerable overtravel in the case of the exhaust edge of the valve, due to the small exhaust lap. Of course the actual opening of the exhaust port is limited by the width of the port, and it is well to draw an arc *rs* on the diagram such that the distance between it and the exhaust-lap circle is equal to the port width. The actual exhaust-port opening can then be seen at once.

"Jiffy" Operating Cutter

The usual way of making an additional hole in a cabinet, to accommodate a piece of conduit, a hole in metal lockers, or inclosing cases, has been the source of considerable trouble. A tool that can be used for cutting metal, fiber and slate and that can be adjusted so as to cut holes of various sizes with little effort and in but a few moments is shown herewith. It is manufactured by the Universal Tool and Appliance Co., Stroh Industrial Building, Milwaukee, Wis.

To use the tool, all that is necessary is to drill a pilot hole through the material and through this pass a stud. A flange-nut is then secured on the opposite side of this stud, and a few operations of a ratchet wrench cut out the hole. The knives, which may be adjusted for cutting



CUTTER IN POSITION TO CUT HOLE

holes of several diameters, are held in a swing chuck and are automatically fed by means of the spring shown between the swing chuck and the knurled nut. This device does the work of a 6-in. drill press, and it can be taken to the work instead of taking the work to it.

Editorials

Boiler Inspectors and Boilermakers

A number of years ago the United States Civil Service Commission decreed that in order to be eligible to the position of engineer of a certain class of public buildings, the candidate must be a graduate of a technical school or college.

Power maintained that the position of the commission was untenable; that the object of the Government was to select the best man for the place, and the business of the commission was to find out what the qualifications of the various candidates were, and not how they got them. The man who had learned the fundamentals of engineering by the light of a kerosene lamp on the kitchen table and studied their application in the actual operation of a power plant might be at least as well qualified to undertake the responsibilities connected with the administration of the mechanical department of a large public building as one who had been steered through a technical school. The commissioners saw the point and revised the specification so that anybody who had the necessary knowledge and experience should be eligible for the appointment, however that knowledge and experience was obtained.

But the wind blows from another quarter, and the shoe is on the other foot.

At the American Uniform Boiler Code Congress in Washington the only false note struck was an attempt on the part of a handful of representatives (appointed with an inadequate idea of the scope and purpose of the congress because they were members of a boilermakers' union) to inject into a broad general discussion of the need and effectiveness of governmental supervision of boilers, a resolution to the effect that no person should be appointed as a boiler inspector who had not had "at least ten years' experience as a journeyman in the construction and repair of boilers."

More recently, bills have been introduced in Oklahoma, Washington and Ohio, prescribing for appointees as boiler inspectors five to ten years' experience, and in Kansas, Missouri and North Carolina from seven to ten years' experience as boilermakers. In South Dakota a bill is pending requiring boiler inspectors to have had ten years' experience in the operating and repairing of boilers, and in Minnesota a bill requiring boiler inspectors to be engineers. The bills pending in Oklahoma, Washington and Ohio require boiler-insurance inspectors also to be boilermakers with five to ten years' practical experience.

It is not our purpose to discuss here the relative merits of boilermakers and engineers as boiler inspectors—we know first-class inspectors who have been neither—but we do venture, in passing, the observation that the effort in behalf of many a beneficent legislative project has lost official and public approval through the interjection of a squabble for individual or class advantage.

What we do contend, and we insist upon it as strongly now as we did when the graduates of the school of experience were disqualified, is that it makes no difference where he got his qualifications, the man who can demonstrate that he is qualified to inspect boilers should have and hold the job.

We yield to nobody in our condemnation of the filling of such positions by political incompetents, of making their tenure of office a function of the varying fortunes of a political boss or party. It is a question of precaution against destruction and death. The inspection department should be composed of specialists in the design, construction, setting and operation of boilers, and their connection with it should offer every encouragement to its members to become expert in their subject, to make it their life study. No man should be intrusted with its responsibilities who has not demonstrated his fitness for the duty, but as to how or where he got that fitness, that is nobody's business but his own.

Massachusetts Refrigeration Safety Bill

House Bill 415 before the Massachusetts Legislature was given a hearing Thursday, Feb. 8. The aim of the bill, as stated in the first section, is that "all refrigerating plants shall be of such construction, and equipped with such devices as may be necessary to make such installation and operation reasonably safe." The bill provides that the formulation of these rules be done by the Board of Boiler Rules and enforced by that body.

Though there is no doubt that public-spirited engineers and laymen of the Commonwealth feel the need of refrigerating safety rules, especially in view of the recent adoption of such rules by other cities and the activity of the American Society of Refrigerating Engineers in this direction, one was impressed by the weakness of the force favoring the bill and by the strength of the opposition, which consisted of representatives of manufacturers of refrigerating machinery. These gentlemen were quite insistent in their assertions that the Board of Boiler Rules was incompetent to formulate such rules and that they should be drawn up by a committee composed of manufacturers. It may be true that the board is not ideally constituted to formulate working rules. We do know that there is available to the board the assistance of the best engineering talent. This assistance would be called in should such a bill as the one mentioned pass. In the preparation of its boiler rules the board has always sought the advice of competent engineers; and before such rules can become law a public hearing must be given them. The talk of incompetency of the board to formulate refrigerating safety rules is therefore mere vociferous piffle.

Mr. Boyer, who marshaled the opposition forces at the hearing, stated that the manufacturers are now getting together to formulate such a bill. We hope they will not be so short-sighted as to not seek the coöperation of consulting and operating refrigerating engineers. Unless this is done, their work will not be satisfactory to all parties affected.

Representative Odlin advised those desiring such legislation to formulate their rules and present them before the legislative hearing. Admirable if the state is willing to appoint a commission and to stand the expense. It is quite likely that the Commonwealth will not get free such services, as it did when the present refrigerating safety-valve rules were formulated.

The more one hears of this refrigeration safety legislation agitation, the more one is convinced that the least expensive and most thoroughly satisfactory solution lies in having the American Society of Refrigerating Engineers and the American Society of Mechanical Engineers jointly formulate a code similar to the Boiler Code. Legislators, engineers, manufacturers and the public generally would recognize in this the best that intelligent coöperation can produce. With such a code, legislatures could and should adopt it *in toto*.

Nearly every legislator who questioned those favoring or opposing the bill before the hearing seemed to insist on asking about the number of accidents to refrigerating machinery "in Massachusetts." As though by some hocus pocus that Commonwealth is immune from or particularly susceptible to failures of such machinery. Unfortunately, it seems necessary that friends of these gentlemen take them aside and convince them that though they must confine their legislation to Massachusetts, mechanics and physics do not respect such geographical boundaries.

The Minimum Charge for an Electric Service

The minimum charge, like all other questions pertaining to what is fair and equitable payment for electric service, has been seriously contested. The fairness of this charge is generally recognized today by public-utility commissions, electrical engineers and central-station companies. The chief argument for the minimum charge is that it covers the expenses that cannot be taken care of in any other way in the ordinary rate schedule and makes it possible that each customer pays his just share of the cost of rendering an electric service to a community.

In a paper read before the recent annual meeting of the Indiana Engineering Society, Peter Junkersfeld, of the Commonwealth Edison Co., pointed out that all the expense per kilowatt-hour (other than fixed charges on the investment) incurred in supplying electrical energy untransformed in bulk to a substation amounted to only about six or seven per cent. of that for rendering complete electric service to a small customer (five customers to the block). Also that the cost of reading the meter each month, entering on the books, rendering the bill and making the collection is about sixteen cents per bill. This is repeated twelve times a year and is a large proportion of a bill for electric service, which is often one dollar a month or less. If there are added the cost of testing the meter, which should be done at least twice a year, and the maintenance and depreciation charges and interest on the capital invested in the meter, it at once becomes apparent that a very small percentage of the average bill to the small customer is left to pay the other costs of rendering service. Therefore not only a minimum charge, but also the higher rate that it is the general practice to charge small consumers seems fair and equitable if they are to bear their share of the cost of producing and supplying energy.

It has been frequently argued among the public, who are not familiar with the cost of a utility service, that a central station should be in a position to render a one-price service similar to that of a merchandizing establishment. It is to be granted that there are cases where the merchant has to render a service for less than cost and that it has to be made up on other items in the business as a whole. However, the difference between an electric service and general merchandizing is that the customer who buys very small quantities of electricity usually remains a small customer and if supplied below cost during a normal month, there is little prospect of his ever becoming a consumer of such proportions that a profit can be realized on the service rendered. On the other hand, in general merchandizing the small customer of today, whose purchase may represent a loss to the establishment rendering the service, may become the large consumer of to-morrow, whose purchases will pay a profit on the service rendered. Also the services rendered for small purchases are not in general the same as for large ones. In the public utility the service rendered in general is the same to all customers; and furthermore, the central station must be in a position to render this service at all times.

It has been pointed out that the diversity factor from residence-lighting customers to the generators is high, being about 5.5. This is true, but one of the most important points in this and in rendering any electric service has been overlooked; namely, that the load factor is low, residence-lighting service requires energy for at most only about four or five hours in the early part of the evening, and at certain times of the year this load overlaps the industrial day load, causing an increase in the central-station peak, which must be taken care of by having sufficient capacity installed, and which involves an additional investment. However, these conditions are not sufficient to warrant the vast difference between the maximum and the minimum charge per kilowatt-hour existing in some localities. Although the small consumers should pay a proportionate share of the cost of an electric service, it is unjust that they be burdened with the expense of making an attractive rate to the large consumer.

Wherever electricity is supplied according to a meter rate, revenue is available only when service is used, and it is common experience that many customers do not use sufficient to incur a bill large enough to meet the fixed expenses; consequently a minimum bill is both necessary and just and has been upheld in general by public-utility commissions and courts whenever they have been called upon to render a decision upon the reasonableness of this charge.

The present air-tank rules of the Commonwealth of Massachusetts apply only to air vessels and not to other pressure tanks. Any tank, air or other medium, is not subject to inspection if carrying not over fifty pounds. Those interested in the protection of the public against explosions will be pleased to know that a bill to include all tanks under dangerous pressures was favorably regarded at the recent legislative hearing on mercantile affairs. We sincerely hope the bill will pass.

Correspondence

Oil-Burning Boiler Furnace

W. G. Camp, in replying, in the issue of Jan. 9, to my criticism of the oil-burning furnace described by him (Sept. 26, 1916), states that results count and that he has cut the fuel consumption 40 per cent. mainly by the change in furnace design and by improved burners. I will admit results are the main point at issue, but Mr. Camp's statement of results has been rather meager. To cut the fuel consumption of many small oil-burning plants 30 to 40 per cent. would not require any change in furnace design whatever. In fact, the only things necessary would be the reduction of the 300 to 400 per cent. of excess air so commonly used and properly cleaned heating surfaces inside and out. Operating methods and conditions "before and after" would give a basis upon which a comparison might be made.

I know of a plant having two 80-hp., rated, return-tubular boilers equipped with large furnaces extending the full length of the boilers and having no bridge-wall or other obstruction, that are carrying a load of 250 hp. each for several hours during the day at an efficiency of 75 per cent. or over. If Mr. Camp's boilers can equal these results, I will admit surprise, but to be advantageous, it would be necessary to exceed these figures, as the original and repair cost would no doubt be considerably higher than for the installation just described.

In altering a coal-burning furnace to use oil fuel, the headroom between the furnace floor and boiler should be increased considerably for the reason that oil in burning is broken up into minute globules, or particles, which are projected by the atomizing agent into the combustion chamber, where they must have ample space to mix with oxygen before coming into contact with the relatively cool boiler surface; they require more room than coal, which lies on the grates and mixes with the oxygen while it is passing through.

The only excuse for using grates in an oil-burning furnace is to support the floor brick. They may be done away with entirely and generally are in modern furnaces.

Del Monte, Calif. A. C. McHUGH.

Replying to criticisms of the oil burner and furnace described by me on page 464, Sept. 26, will say that I tried to make it plain in that and a succeeding letter that the condition of the boiler shells and tubes is first-class. There is none of the sticky deposit so noticeable on many oil-burning boilers, on the shells or tubes, as the fire burns clean and absolutely smokelessly even when the boilers are being forced. When I took charge of this plant two years ago, a number of the tubes were leaking at the rear ends, but I have not had a leak in over a year.

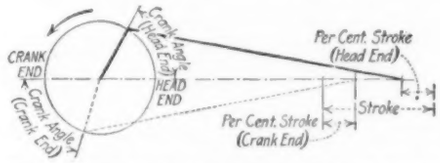
The burners never need cleaning except when we get a car of exceptionally heavy, tarry oil. As to the steam required by the burner, with steam at 100 lb. pressure an ordinary ½-in. bevel-seat globe valve open one-eighth of one turn will give all the steam needed for the heaviest fire. When we cut out a boiler, we use steam from it to run the burners, and they work all right until the pressure goes down to 5 lb.; then we cut in steam from a live boiler.

We evaporate approximately 14 lb. water from 160 deg. to steam at 100 lb. pressure, per pound of oil. The oil averages about 18,000 B.t.u. per lb. I attribute the good results more to the furnace and the condition of the boilers than to the burner. W. G. CAMP.

Ash Fork, Ariz.

Comparative Movement of Crank and Piston

The "Comparative Movement of Crank and Piston," as published in *Power*, Dec. 26, 1916, p. 890, would, in my opinion, permit of more practical use for general conditions if given in graphical form, as here illustrated.[1] This particular curve shows the piston travel, crank end and head end, per degree of crank movement for a 5:1 ratio of rod to crank. The method of calculation is given so that similar curves may be produced for any desired crank ratio. The advantage claimed for the curve over a table is that in this form the approximate percentage of piston travel can be read direct for any angle, and where the curve is plotted in sufficiently large scale the results thus obtained are accurate enough for all practical purposes.



Per Cent. Piston Travels for Corresponding Crank Angles, 5 Crank Connecting Rods

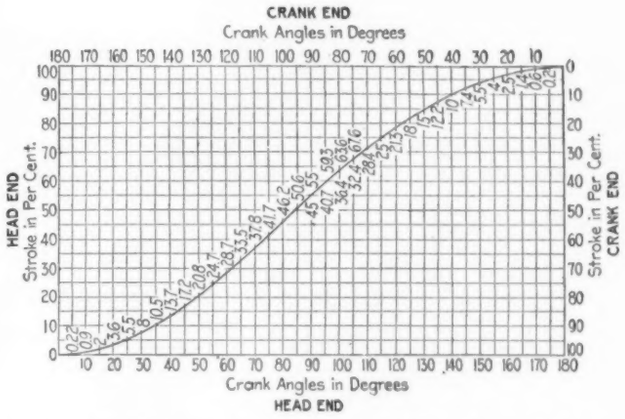

CRANK END
Crank Angles in Degrees
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
HEAD END
Stroke in Per Cent.
CRANK END
Stroke in Per Cent.
Crank Angles in Degrees
HEAD END

DIAGRAM OF RELATIVE PISTON AND CRANK TRAVEL

[1] The original diagram is 16x20. It is reproduced here upon this reduced scale, not with the expectation that it will be legible and useful for reference, but that it may serve to suggest and direct the reproduction of similar diagrams upon the large scale needed for accurate reading.—Editor.

I have found the curve of much practical use in calculating the pressure within the cylinder at different crank angles and in determining the distance the piston has traveled when the valves open, the valve opening being usually expressed in degrees crank angle.

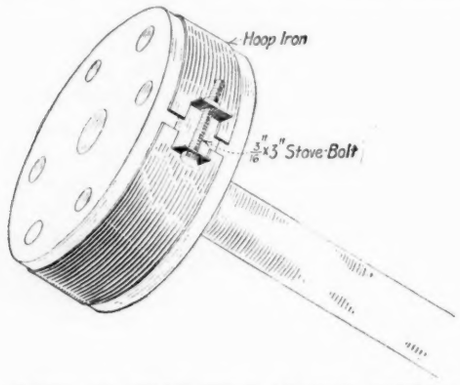
The use of the diagram is apparent. For example, assume a stroke of 24 in. and a connecting-rod length of 60 in.; that is, a ratio of rod length to crank of 5. By referring to the curve it will be seen that a crank movement of 50 deg. from the head end represents a piston travel of 15 per cent. of the stroke, or $0.15 \times 24 = 3.60$ in.

J. G. FARRAR.

Auburn, N. Y.

Clamp for Piston Rings

I don't suppose there is an engineer that has not lost patience in trying to enter a piston and rings into the cylinder, and it certainly is a hard task sometimes. I use a piece of band or hoop iron about three-fourths



BAND OF HOOP IRON AROUND PISTON

the width of the piston and about ½ in. shorter than the circumference of the piston, drill a $\frac{3}{16}$- or ¼-in. hole in each end of the strap, then bend up about ½ in. of each end. I then put in a bolt about 3 in. long, threaded nearly full length, put the band around the piston and draw up with the bolt. This holds the rings and makes it easy to insert the piston.

E. L. DAVIS.

Rosedale, Kan.

Freeing Threads on Valve Stems

I think Mr. Williams would have overcome his trouble, described on page 96 in the issue of Jan. 16, more easily and sensibly by using a little oil occasionally on the stems of seldom-used valves. These valves are made carefully and work easily, the makers knowing just the right amount of clearance to give the threads and if given reasonable care, the same as other appurtenances in an engine or boiler room, they will never cause any trouble.

This is a subject that requires a little of the engineer's thought, especially with the now commonly used nonreturn type of valve on boilers. In common practice these valves are seldom given any attention by the boiler attendant, the valve cutting the boiler out of the line and in again automatically. This practice recently caused quite a little annoyance in one plant. The fireman brought the pressure up rather rapidly, and when the line pressure was reached, the nonreturn valve cut the boiler in on the line and, as the fire was quite heavy and there was no drain on the superheater, enough steam came over into the main to empty the superheater water into the turbines, reducing their speed and lowering the voltage so that the automatics on the various motors let go. It took quite a while to get all the motors running again.

This shows the human disposition to "ride a free horse to death" and is like the treatment given much other apparatus about a power plant, such as damper regulators, reducing valves, cylinder relief valves and even the safety valves. These seldom-used valves are so well made that the attendant often neglects to give them the little care that will insure their being in good working order when required.

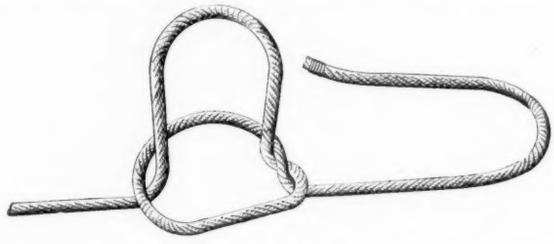
Very often, when these valves are leaking through the stuffing-box, they are not noticed, and soon the bolts and nuts rust together, and when someone undertakes to pack them, the stems stick and the studs of the stuffing-box break off in the valve bonnet, etc. These little, neglected things cause more trouble and annoyance than the largest boiler or engine.

JOHN M. COLEMAN.

Somerville, Mass.

New Way of Tying a Bowline Knot

I early discovered that tying a bowline knot would prove a fizzle if the end of rope was put through the loop the wrong direction, so found a way to avoid it. I first make a slip knot, backward from the end of the rope, then put the end of the rope through the loop of the slip knot, lay it back on itself, push this loop through the hole of the slip knot and pull up on the rope. This causes the round part of bight of the slip knot to turn over, and pulling evenly on both the loop-end and the



FIRST LOOP OF BOW LINE OR MARLIN-SPIKE HITCH

rope tightens the bowline. This slip knot made backward is known as the marlin-spike hitch.

A knot can be quickly made in this way, and it makes no difference which way the end of the rope is put through the loop of the slip knot or marlin-spike hitch.

Kilbourn, Wis. N. C. PIERCE.

Design of Oil-Ring Bearings

Referring to the able treatise by William Knight on the "Design of Oil-Ring Bearings," page 42, Jan. 9 issue, where the author states (page 45, paragraph 8) that "in order to obtain as good a contact as possible between the lining and the shell in a journal box, the bearing-metal lining must be carefully peened," is not this necessity for peening open to question?

My experience with babbitted induction-motor bearings indicates that peening is not desirable. This also applies to crosshead shoes and crankpin boxes on reciprocating engines and air compressors, and to large crushing-roll, gyratory and jaw-crusher bearings using a

babbitt metal approximately 84 per cent. tin, 8 per cent. copper and 8 per cent. antimony.

Peening such bearings seems to destroy the structure of the babbitt and render it more liable to crack in service. I find that a carefully heated babbitt poured on a warm, dry surface gives better results when not peened. In cases where it is possible to uniformly compress the babbitt metal by forcing a polished cylindrical broach through the bearing after pouring, this proves beneficial, but the usual method of hammer peening does not, in my case, give good results. CHARLES F. HUNTER.

Mineville, N. Y.

Valve Closed When Tube Blew Out

One of the 4-in. tubes of a 250-hp. water-tube boiler blew out one night recently in our plant and slammed the fire-door so hard against the door check that the latter was broken. This check protects the water-gage blow-down pipe when the door is opened all the way. The escaping steam and hot water immediately filled the boiler room, but fortunately no one was in front of the boiler at the time. The nonreturn stop valve worked promptly and seated perfectly. The worth and efficiency of this type of valve was once more demonstrated, as the boiler was one of a battery of eight.

The boiler is of the two-drum type. The bursted tube was in the second row up from the grate, and as the tubes are staggered this one is directly over the fire. Upon examination, the hole in the tube was found to be 14 in. long; no scale was inside, and the tube was not burned. The bursted tube and one obliquely under it were replaced with new ones, as it was feared that the one below might have been weakened. The blowout occurred about 5 ft. from the front of the boiler. It was found necessary to replace 10 nipples in the upper front of the boiler. The cause of the failure could only be ascribed to a weak tube. BRONSON RETLAW.

Philadelphia, Penn.

Water Rates of Auxiliaries

R. von Fabrice's article on "Water Rates of Auxiliaries," in the Dec. 26 issue, is very interesting and should be of great value to engineers and power-plant owners as well as to salesmen. In reading the article and applying other curves of a similar character to his, one is able not only to arrive at the cost of evaporating 1000 lb. of water from and at 212 deg. F., but also to obtain the cost per boiler horsepower. I note, however, that his statements and formula as given for obtaining the water evaporated per pound of coal are misleading, which warrants a proper definition of the term efficiency.

Efficiency in its broadest sense is a ratio of the output to the input. In dealing with boilers we have two efficiencies—the combined boiler and furnace efficiency and the boiler efficiency alone. The combined boiler and furnace efficiency is a ratio of the B.t.u. absorbed by the water in the boiler to the B.t.u. available in the fuel as fired, or it is a ratio of the heat absorbed per pound of fuel as fired to the heat, or calorific value, of one pound of fuel as fired. The boiler efficiency alone is a ratio of the heat absorbed by the water in the boiler to the B.t.u. liberated on the grate, or it is a ratio of the heat absorbed per pound of combustible burned to the heat, or calorific value, of one pound of combustible as fired.

From this formula we may find either the equivalent evaporation from and at 212 deg. F. per pound of fuel as fired or the equivalent evaporation from and at 212 deg. F. per pound of combustible burned. In the article in question these quantities are mixed. In his formula he states that

$$E = \frac{Hf}{L}$$

where

E = Evaporation per pound of coal;
H = B.t.u. in fuel = 13,500;
f = Boiler efficiency = 65 per cent.;
L = Latent heat, or B.t.u. required to evaporate 1 lb. of water from and at 212 deg. = 970.4.

It is not stated whether E is per pound of dry or wet coal or whether it is actual or equivalent evaporation from and at 212 deg. F., nor whether H is per pound of dry or wet coal or per pound of combustible. Whenever a formula is given, the characters must be clearly defined, otherwise confusion will result. To illustrate this, let us return to our definition of efficiencies and express them in the form of a formula and there is obtained for the combined boiler and furnace efficiency,

$$f = \frac{EL}{H}$$

where

f = Combined boiler and furnace efficiency;
E = Equivalent evaporation from and at 212 deg. F. per pound of coal as fired, pounds;
H = Heat or calorific value per pound of coal as fired, B.t.u.;
L = 970.4 B.t.u.

Solving from this for E, the result is

$$E = \frac{Hf}{L}$$

The water actually evaporated per pound of coal as fired would be equal to the value of E as obtained divided by the factor of evaporation.

Boiler efficiency alone may be expressed by the formula,

$$f = \frac{EL}{H}$$

where

f = Efficiency of boiler alone;
E = Equivalent evaporation from and at 212 deg. F. per pound of combustible burned, pounds;
H = Heat or calorific value per pound of combustible as fired, B.t.u.;
L = 970.4 B.t.u.

From this we have

$$E = \frac{Hf}{L}$$

In this formula may be substituted the numerical values as given by Mr. von Fabrice, provided they are stated as above. Then

$$E = \frac{13{,}500 \times 0.65}{970.4} = 9.04 \textit{ lb. of water}$$

evaporated from and at 212 deg. F. per pound of combustible burned.

In using either of these formulas E is not the evaporation per pound of coal, as stated by Mr. von Fabrice, but must be expressed as equivalent evaporation from and at

212 deg. F. per pound of coal as fired or per pound of combustible burned.

In order not to confuse the user of the curves as shown in this article, the top left-hand curves should be for boiler and furnace efficiency and the ordinates should read 1000 B.t.u. per pound of coal as fired and equivalent evaporation from and at 212 deg. F. per pound of coal as fired. The values of *f*, *H* and *E* should be as stated for the combined boiler and furnace efficiency.

Chicago, Ill. E. S. LIBBY.

The Coal Problem of Today

In the issue of Jan. 30, page 162, Asa P. Hyde voices a rather common feeling among large coal consumers. There is a method of relief for those who have reached a similar state of mind and are disposed to look for help. It is only fair, however, to say that his general statement regarding the quality of coal is very much too broad. There are hundreds of mines that do ship very poor coal, but many turn out coal of fair quality and a few actually pride themselves on good quality and preparation. It is also true that, during the unusual conditions of the past two years, preparation has dropped off considerably in many cases—much more in some than in others—and there has also been considerable pillar coal and coal from country banks shipped and sold because of these special market conditions. Neither of these points, however, should be considered fundamental in the matter of coal selling, which Mr. Hyde finds so faulty.

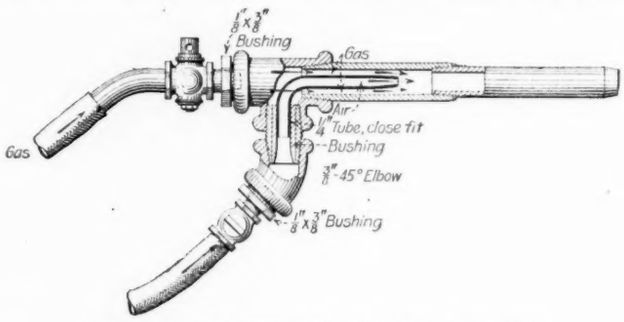
To get down to the real point, in the closing paragraph of his letter Mr. Hyde, speaking as an individual coal user dependent upon his own resources and information, is undoubtedly correct in saying that the coal test is not satisfactory, but the fault is not so much with the coal producers and dealers as it is with consumers, who, as a class, have not exercised enough discrimination in selecting their coal and coal dealer. There is no such thing as consumers being forced to take what the dealer chooses to deliver, except under unusual conditions of coal scarcity.

To take a homely example, suppose a housewife finds from experience that butcher A gives her rather poor meat and, after trying two or three others without much success, finds that butcher B delivers uniformly good meat at reasonable prices. This is a tiresome, expensive process, but organized consumers' demands can get anything within reason from the sellers of a competitive commodity. This same principle holds true of the coal trade, but is much more complicated than the simple example given. There are many different plants requiring different kinds of coal, but no coal producer or dealer controls all the coal any one plant can use. There are competent individuals and firms that act in an advisory capacity in connection with the purchase of coal, and in conjunction with this work systematic tests are made of the coal delivered to hundreds of plants—hundreds of tests a month. Data of these tests, together with other related matters of importance in buying, are daily classified in such a way that each consumer can know what kind of a record the various coals and dealers have established at other plants, and it is then possible to exercise discrimination in selection. Of course this does not guarantee that future deliveries will conform to past practice, but a record of previous years is an infinitely better basis than most buyers have to depend on. There are other incentives to the producer to make good under such circumstances, and the beneficial effects on the buyer are just as clear-cut. The solution of the so-called coal problem, of which Mr. Hyde complains, is entirely in the hands of the consumers, who are largely, though inadvertently, responsible for its existence; they can make big strides toward ending it when they begin to think as Mr. Hyde does and seek a way out. G. B. GOULD.

New York City.

Blowpipe Made from Pipe Fittings

The illustration shows a blowpipe for soldering, brazing, etc., made from pipe fittings. A copper or brass tube about ¼ in. diameter is filled with melted lead and given a right-angle bend so that it will go into a ⅜-in. tee as shown, after which the lead is melted out. A brass or fiber bushing is then driven into a ⅜-in. short nipple and drilled out to take the bent tube, which should make a close working fit, and the tube is driven into the bushing and the bushing screwed into the tee, the tube turning in the bushing while the nipple is being screwed in. A ⅜-in. nipple about three inches long is then screwed into the end of the tee over the air nozzle, and a ⅛x⅜-in.



BLOWPIPE ASSEMBLED READY FOR USE

bushing is screwed into the other end. The air tube should be adjusted centrally in the ⅜x3-in. nipple. Valves or cocks are used to regulate the flow of air and gas.

The apparatus has been found to work best when the air flows through the bent tube as shown and the gas is led through the straight portion of the tee. Any size or shape of nozzle may be used, depending on the character of work to be heated. H. H. PARKER.

Oakland, Calif.

Results with Sawdust as Fuel

Sawdust is extensively used as fuel in the Puget Sound locality, and we have used it for several years with entirely satisfactory results. The following data were from a 72-hr. test on three return-tubular boilers equipped with dutch ovens and conveyor-chain chute feeder.

Total area of grates (3 boilers)	90.8
Total rated horsepower of boilers	402
Horsepower developed	732
Percentage of rating	182
Steam pressure, lb.	100
Temperature of feed water, deg. F	202
Heat value of dry fuel, B.t.u. per lb	8,500
Percentage of moisture	52
Water fed per pound of fuel burned	4.45
Fuel burned as fed, per boiler horsepower developed	8.6
Fuel burned per square foot grate surface per hour, lb.	69.4
Cost per ton	$0.62
Cost per hour (3⅛ tons)	1.95

Creosote, Wash. M. A. THOMAS.

Inquiries of General Interest

Load Producing Visible Slip of Boiler Joint—What loads are required to produce slip in double machine-riveted boiler joints using ¾-in. rivets and when using 1-in. rivets? W. L. J.

When good machine riveting is done, the joint will begin to slip visibly with ¾-in. rivets for a load of about 7 tons per rivet, and with 1-in. rivets for a load of about 9 tons per rivet.

Equalizing Draft of Boilers Set in Battery—What can be done to equalize the draft of three horizontal return-tubular boilers set in battery with uptakes connected into a common breeching? R. B.

Provide a baffle in the common breeching so that the gases from the boiler farthest from the stack will be guided in an easy passage over or to one side of the uptake connection of the second boiler, and another similar baffle for guiding the gases from the first and second boilers past the uptake connection of the third boiler.

Power Factor of a Three-Phase Alternator—How can the power factor of a three-phase alternator be determined? The voltmeter indicates 2300, the ammeter 80 and the wattmeter 285 kw. H. S.

The power factor of a three-phase alternator may be calculated, when the volts, amperes and kilowatts are known, by the formula,

$$\text{Power factor} = \frac{\text{Kilowatts} \times 1000}{\text{Volts} \times \text{amperes} \times 1.732}$$

In this problem

$$\text{Power factor} = \frac{285 \times 1000}{2300 \times 80 \times 1.732} = 0.89$$

Capacity of Center-Packed Plunger Pump—How many gallons of water would be handled per hour by a center-packed double-acting duplex plunger pump having plungers 10 in. diameter by 12-in. stroke, and rod 2 in. diameter, when run at an average plunger speed of 40 ft. per min.? F. G.

For each side of the pump there would be 20 discharge strokes per minute from the rod end of the plunger and the same number from the head end. The cross-sectional area of the plunger displacement on the head end would be $10 \times 10 \times 0.7854 = 78.54$ sq.in., and the net cross-section area of the displacement on the rod end would be $78.54 - (2 \times 2 \times 0.7854) = 75.4$ sq.in., and the total displacement per hour, in both sides of the pump, would be $(78.54 + 75.4) \times 12 \times 20 \times 2 \times 60 = 4{,}433{,}472$ cu.in. Hence, without allowance for slippage the pump would handle $4{,}433{,}472 \div 231 = 19{,}192.5$ gal. per hr.

Three-Wire Versus Two-Wire System—What are the advantages of a 120- to 240-volt three-wire system over a 120- or 240-volt two-wire system? J. J. M.

There is no logical reason for operating motors at a lower voltage than 240, except very small machines used to drive household devices that operate from a lighting circuit. On the other hand, 110-volt or lower-voltage incandescent lamps are more rugged and efficient than the 240-volt type. It is desirable in most cases to combine the direct-current power and lighting load on the same circuit. This is made possible by using a three-wire system, and at the same time it allows the motors to be operated on 240 volts and the lights on 120 volts. Another advantage is the saving in copper. This depends somewhat upon the size of the neutral wire. Where the neutral is the same size as the outside conductor, and it need be no larger, the saving, when transmitting a given load with the same percentage loss in the line, is in a ratio of 3 to 8 in favor of the three-wire system.

Advantage of Compounding—What is the advantage of a compound over a simple engine in the use of steam expansively? R. E. L.

During each revolution of an engine the walls of the cylinder are alternately heated by the admission of fresh steam and cooled by the lower temperature of the steam during expansion and the discharge of the exhaust. The cold walls cause condensation of steam during admission and possibly during the early part of the expansion, with a transfer of heat at the rate of 20 to 25 B.t.u. per sq.ft. per degree of temperature difference per minute. When the expansion is performed by compounding, the temperature difference is less in each cylinder and there is less loss from cylinder condensation. From this cause, combined with the advantage of employing higher initial pressure and sustaining lower leakage and clearance losses, the economy of a compound engine may be 20 to 25 per cent. better than that of simple engines, and the triple-expansion engine may use 10 to 15 per cent. less steam than the compound.

Safe Working Pressure for Boiler Joint—What would be the safe working pressure for the longitudinal seam of a boiler shell 72 in. diameter, where the thickness of the plate is $\frac{7}{16}$ in., tensile strength of plate 55,000 lb. per sq.in. of cross-section, efficiency of joint 75 per cent. and factor of safety 5? E. P.

The safe working pressure is given by the formula

$$p = \frac{t \times TS \times E}{r \times FS}$$

in which

p = Safe working pressure, lb. per sq.in.;
t = Thickness of shell plate, in.;
TS = Tensile strength of plate, lb. per sq.in. of cross-section;
E = Percentage of efficiency of the joint;
r = Radius of the shell;
FS = Factor of safety.

Substituting the given values, the formula becomes

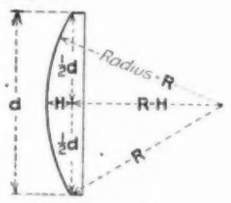
$$p = \frac{\frac{7}{16} \times 55{,}000 \times 0.75}{(\frac{1}{2} \text{ of } 72) \times 5} = 99.8,$$

or practically 100 lb. per sq.in.

Finding Height of Bumped Head—What would be the rise, or height, of a spherical bumped head 72 in. diameter, if dished or bumped to a radius of 72 in.? J. E. S.

In the figure if

R = Radius to which the head is bumped;
d = Diameter of the head; and
H = Height to which the head is bumped:



then as

$$R^2 = \left(\frac{d}{2}\right)^2 + (R - H)^2$$

$$H = R - \sqrt{R^2 - \frac{d^2}{4}}$$

Substituting 72 for R and for d, the height will be

$$H = 72 - \sqrt{(72)^2 - \frac{(72)^2}{4}} = 9.65, \text{ or about } 9\tfrac{5}{8} \text{ in.}$$

Hydrostatic and Hammer Testing of Boilers—What are the advantages and disadvantages of hydrostatic and hammer tests of a boiler? H. C.

A hydrostatic test can only determine whether the boiler is tight when subjected to the pressure and temperature at which it is tested. It is not, however, conclusive proof of the boiler's tightness or safety when used under pressure, temperature and other conditions existing for generation of steam. An objection to hydrostatic testing is that stresses induced by the test are likely to impair the usefulness of stays and other fastening by producing a set in the material that may render connections inoperative. Tightness under hydrostatic test, without expert examination of the structural conditions, may lead to an erroneous assumption as to the safety of a boiler.

The purpose of a hammer test is to determine the structural condition of the boiler as a basis for estimates of the safe working pressure, probable rate of deterioration and needed repairs. The disadvantages of a hammer test are that the inspection may not thoroughly cover all vulnerable parts of a boiler and computations of the strength of parts may be based on erroneous estimates of the conditions.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

NEW PUBLICATIONS

HANDBOOK FOR MACHINE DESIGNERS, SHOP MEN AND DRAFTSMEN—By F. A. Halsey. Second edition. Five hundred and sixty-one 8¼x11-in. pages; illustrated; indexed; cloth bound. Published by the McGraw-Hill Book Co., New York City. Price $5.

This is the second edition of Mr. Halsey's well-known handbook. The rapid accumulation of essential information in the field of this book during the brief period of three years has made extensive additions and revisions necessary. The first volume had a total of 494 pages. The new edition has 67 pages more. The title has been modified by adding the words "Shop Men." This has been done more clearly to indicate the nature of the material included. In the revision gaps in the information presented in the first volume have been filled and some subjects have been rewritten in the light of additional information. The original scheme of the book—that is, the profuse use of charts and graphical plotting—has been continued.

In looking through a second edition the reviewer searches for those topics which were not found in the first edition or those which have been extensively revised. The preface gives such a list, which, in spite of its length, is quoted herewith: "Thrust bearings, knife-edge bearings, roller bearings, critical speeds of shafts, riding and steel belts, geometrical progression of speeds, strength of spur and herringbone gears, gaging gear teeth, cutting bevel gears with rotary cutters, modified addendum of bevel gears, axial thrust of bevel gears, skew bevel gears, practice with friction gears, worm gears, roller chains, friction clutches, spiral springs of the watch-spring type, wire system of measuring screw threads, properties and strength of wire, capacity of horizontal tanks, weirs, standard pipe tables, pipe flanges and fittings, measurements of tapers and dovetails, forming and other tools, press fits, balancing revolving parts, floating lever, velocity and force relations in link work, permissible cost of special shop equipment, weight of solids of revolutions, diameter of shell blanks, power consumed by drilling machines, Taylor cutting speeds, hardness tests, heat treatment of steel, temperature equivalents of temper color, material for steam boilers and proportions of riveted joints, discharge capacity of safety valves, properties of superheated steam, steam pipe coverings, approximate beams of uniform section, strength of columns, materials and construction for resisting shock."

In several of the new sections and in the last one of the book are incorporated a number of new tables. A study of this list shows that the revision has included considerable material of a purely shop nature, which is justification for the change in the title noted above.

American Association of Engineers Meets

The ethical and social responsibilities of engineers and engineering as a career were the main points of consideration at a nontechnical "get together" meeting of the American Association of Engineers, held at Chicago on Feb. 10. This association aims at the improvement of the engineer's professional and public relations, and one of its leading activities is in acting as an employment agency for its members. An ambitious three-day program had been prepared, but some of the meetings were not held, and the principal activities were on the afternoon of Feb. 10.

Engineering ethics, as a guide in the personal and professional activities of the engineer, and in relation to his position before the public, was presented interestingly by Prof. F. H. Newell. In a paper on "Civil Service and the Engineer," by Garrison Babcock, it was stated that the civil-service system is closer to the engineering profession than is any other arm of the Government. It represents scientific principles in public enterprise and is the channel through which good engineering must enter public service. A discussion on this was presented by William B. Hale, of the Chicago Civil Service Reform Association.

The problem of minimum qualifications for membership has become increasingly insistent with the growth of the association, and a paper on the situation was presented by N. M. Stineman. The difficulties arise as to both the educational and the professional experience. For the latter it is held that experience means the solving of engineering problems. This is not likely to come within the work of rodmen or tracers, but is involved in that of designers, transitmen, etc. The paper strongly favored a full college training as a qualification, but there was some dissent to this in the discussion. Mr. Stineman admitted that allowance must be made for those who have educated themselves through correspondence schools, technical high schools or partial courses in engineering colleges. On the other hand, he thinks that much greater consideration is due to those who by hard self-denial have secured a thorough college training. He urged the exclusion of men of inferior qualifications; that is, the young man who thinks he is an engineer when he has learned the use of drawing instruments; the small contractor who finds it profitable to call himself a contracting engineer; the sidewalk builder who calls himself a concrete engineer, and the plumber who thinks he is a sanitary engineer.

All in a Day's Work

Commenting upon the fire which gutted the Hotel Lenox early on the morning of Feb. 10, the Boston "Globe" says that D. B. Hanlon, the night engineer, was one of the real heroes, for he kept the service elevator running and brought to safety a large number of guests from their rooms on the upper floors. In a subsequent interview, Mr. Hanlon is reported to have said:

It was about 4:55, when as I was sitting in the engine room, reading, I began to smell smoke. I knew what was happening all right, and shouting to the fireman to keep up the fires and at the same time watch my engines—for I had to keep the power up to run the car—I jumped for the elevator and rushed up to the tenth floor.

I don't know how many trips I made. I figured that the people on the lower floors could walk down, so I tried to clear them from the upper floors, the women first when I could. I averaged from eight to ten at a trip and ran up and down as fast as I could go. I think I must have made 50 trips in the first hour.

It got smoky first, and then hot. I had a wet towel over my face and head to keep off the smoke, and on most of the floors the flames did not get to the service elevator, though the other elevators on the Boylston St. side were killed, I think, from the start.

On the fifth and the eighth floors the flames burned the doors from the well, and it was like going through a furnace to pass them. But I stopped just long enough to soak a sheet and threw that over me, and then kept on running.

A fireman warned me not to try to go above the seventh floor, but I made a final trip up to the eighth and found two women there in their night clothes, an elderly woman carrying a baby and a younger woman whom I took to be the baby's mother. I don't know who they were—they went over to the club.

Hanlon's place in the engine room was taken by William E. Lucas, of 5 Whitfield St., Dorchester, the night engineer at the Copley Square Hotel. He said:

As soon as I heard the engines and saw there was a fire at the Lenox, I told my fireman to watch the engine room, as I was going over there. I had worked there and knew everybody in the place and thought I could help.

I found Hanlon on the car and took his place at the engines. There was a flood of water coming down the elevator well and the stairs, but we kept the power and the lights on, with only two or three limited short-circuits.

PERSONALS

C. C. Cleland has been appointed sales manager of the Reliance Gauge Column Co., Cleveland, Ohio, in place of F. Roberts, resigned.

H. B. Hill, for the past eight years with the Lagonda Manufacturing Co., is now in charge of the Philadelphia branch of the Strong, Carlisle & Hammond Co.

Alexander F. Smith, formerly engineer at the N. H. Spinning Mill, Penacook, N. H., is now master mechanic with the Mianus Manufacturing Co., Cos Cob, Conn.

Elmer Kechler, who has been chief engineer of the Franklin (Penn.) Steel Co., has been made master mechanic of the company, to succeed J. S. Green, resigned.

Robert S. Griffin, engineer-in-chief of the United States Navy, has been promoted to the rank of rear-admiral. He is also chief of the Bureau of Construction and Repair.

F. E. Ransley has accepted a position as manager of the packing department of the Doermann-Roehrer Co., of Cincinnati, one of the largest specialty houses in the state.

J. S. Green, formerly master mechanic of the Franklin Steel Works, Franklin, Penn., resigned to go with the Wickwire Steel Co., Buffalo, N. Y., to aid in the installation of the latter company's new plant.

Cyrus Corliss has been appointed construction engineer of the department of power, Boston Elevated Ry. For the past 11 years he has been asssitant to Paul Winsor, chief engineer of motive power and rolling stock.

E. B. Merriam, for several years assistant engineer of the switchboard department of the General Electric Co., now heads the recently organized industrial-service department of the company, to supervise education, employment and provision of opportunities for advancement of employees at the Schenectady plant.

Gen. George W. Goethals, recently chief engineer of the Panama Canal and governor of the Canal Zone, has opened consulting engineering offices in the Wall Street Exchange Building, 43 Exchange Place, New York. He has associated with him experienced specialists in civil, electrical, mechanical and hydraulic engineering.

Douglas I. McKay and Sanger B. Steel were recently elected vice-presidents of the J. G. White & Co., Inc. Mr. McKay was at one time police commissioner of New York City and for the last two years has been assistant to the president of the White Corporation. Mr. Steel, prior to this appointment, was manager of the Chicago office of the brokerage firm of Paine, Webber & Co.

Dr. W. F. M. Goss, for many years associated with the Schools of Engineering, Purdue University, and since 1907 dean of the College of Engineering of the University of Illinois, has resigned that office, effective Mar. 1, 1917, to assume the presidency of the Railway Car Manufacturers' Association, an office to which he was elected on Feb. 1, subject to his release by the university authorities.

OBITUARY

George Ross, inventor of the Ross valve and president of the Ross Valve Manufacturing Co., died at his home in Troy, N. Y., on Feb. 9. He was 88 years old.

James Terry, president of the Terry Steam Turbine Co., of Hartford, Conn., died on Feb. 3, in his 44th year. Mr. Terry was born in Hartford and graduated from Sheffield Scientific School of Yale University in 1895. He was the son of the late E. C. Terry, the inventor of the turbine and founder of the present company. James Terry, upon the death of his father about nine years ago, followed up the commercial development of the company, bringing it to its present successful stage.

ENGINEERING AFFAIRS

The Canadian Mining Institute will hold its nineteenth annual meeting in Montreal, Mar. 7-9, with headquarters at the Ritz-Carlton Hotel.

The Pittsburgh Section of the Association of Iron and Steel Electrical Engineers will hold a meeting at the Fort Pitt Hotel on Mar. 17, under the auspices of the Electrical Development Committee.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will be held on Mar. 3. The speaker of the evening will be C. T. Henderson, of the Cutler-Hammer Manufacturing Co., Milwaukee, Wis.

Protective Association, No. 23, N. A. S. E., held its annual banquet and dance at the West End Café, New York City, on Saturday, February 10. The main dining hall was neatly decorated and there was an overflow after the seats had all been taken. At 9:30 an appetizing dinner was served, which was followed by dancing. The New York "Bunch" entertained at intervals during the dinner. Messrs. Paulsen and Miller as usual were the busy bees of the Arrangement Committee.

Engineers Offer Services to City—The services of the engineers of Atlanta have been offered to the city for the formation of the engineering commission authorized by the council. The board is to consist of five consulting engineers, whose services will be tendered the city free of charge on all matters pertaining to the city government, where the services of an engineer are needed. The men selected will be members of the engineering group comprising the technical societies of Atlanta, which embraces the local branches of the Institute of Architects, the Society of Civil Engineers, the Institute of Electrical Engineers, the Society of Mechanical Engineers and the American Chemical Society. Mayor Candler has requested the names of all engineers affiliated with these societies before making his appointments on the commission. It will be the purpose of the city to call on the commission for expert advice on all matters pertaining to engineering problems in the city government.

MISCELLANEOUS NEWS

A Municipally Owned Gas Plant may soon be built at Sausalito, Calif., if the Pacific Gas and Electric Co. continues to refuse to operate there. The fight for gas has extended over 10 years.

The Missouri State Public Service Commission in its annual report, submitted at Jefferson City on Jan. 30, showed the Missouri Electric Co. profits to be 25 per cent. on the investment. The report has to do only with the transactions of utilities supposed to be owned by the North American, comprising the United Railways, the St. Louis Union Electric and the Missouri Electric Co.

The Niagara Hydro-Electric System's financial returns for the year ending Oct. 31, 1916, were made public on Feb. 1, after the meeting of the Provincial Commission, and showed a surplus of $351,853, Toronto alone making $96,724. The total average horsepower used in the system was 109,583, at an average cost of $9.10 per hp. It will be interesting to see, after another year, how the increased price for the 50,000 additional horsepower, which was contracted for at $12 per hp., and other contingencies work out.

In a Boiler Explosion on a Frisco Freight Train near Grandview, Mo., on Jan. 19, three persons, the engineer, fireman and brakeman, were killed. The boiler was lifted completely off the engine truck and blown 200 ft. ahead into an embankment. The body of the engineer was found in a field about 75 ft. from the scene of the accident. Members of the train crews who viewed the wreck could assign no reason for the accident other than that of low water, which caused the crownsheet and the stay-bolts to give way.

Refrigerating Apparatus on Shipboard—At the recent convention of the Marine Engineers' Beneficial Association at Washington the following resolution was adopted:

Whereas, In the interest of safety first, the Bureau of Fire Prevention of several cities of the United States coöperating with like committees of state authority have adopted rules governing the installation of refrigerating machinery in buildings; and

Whereas, The safety-first rule should apply to all marine installations in the interest of the passengers and crews and particularly those engaged in the operation of refrigerating machinery of steamships; be it

Resolved, That this convention indorse and recommend to the Board of Supervising Inspectors of the United States that suitable regulations be adopted by said inspectors for the installing of refrigerating machinery upon shipboard that the maximum safety be obtained along the following lines:

Every refrigerating machine using a chemical which is deleterious or dangerous to health when inhaled into the lungs of the attendant shall be provided with an automatic relief valve to discharge the chemical outboard in case of excessive pressures from any cause. The maximum pressure will be: Ammonia not to exceed 300 lb. per sq.in.; carbon dioxide not to exceed 1400 lb. per sq.in.; sulphur dioxide not to exceed 100 lb. per sq.in.; ethyl chloride not to exceed 100 lb. per sq.in.

All pipes used for refrigerating purposes shall stand a hydrostatic test of at least double the maximum pressure per square inch as specified above, and all fittings shall stand a pressure of at least three times the maximum pressure per square inch as specified above. All gage glasses shall be adequately protected and provided with shut-off valves.

BUSINESS NOTES

The Vincent & Gilson Engineering Co. announces its representation in this territory of the Precision Instrument Co., with offices at 30 Church St., New York City.

The Jeffrey Manufacturing Co. has recently opened a new branch office at 421-423 Rockefeller Building, Cleveland, Ohio, which is in charge of W. E. Holloway and C. B. Reed.

The Richardson-Phenix Co. announces the opening of a sales office in the Builders' Exchange, Cleveland, Ohio, with W. J. Oettinger, of the engineering department of the home office of the company, in charge.

L. S. Shaw announces the establishing of the firm of L. S. Shaw & Co., with offices in the Dime Bank Building, Detroit, Mich. The concern will deal in power-plant equipment, specializing in high-grade apparatus.

The Magnolia Metal Co. has purchased property in San Francisco and will begin at once the erection of a factory for the manufacture of its metal and other babbitts and white-metal alloys. This action was necessitated by the growth of its trade on the Pacific Coast.

Allen & Garcia Co., consulting and constructing engineers, McCormick Building, Chicago, announce the establishment of a power department, which will be in charge of C. M. Garland, who is widely known as an expert in the different phases of steam and gas-power engineering. The electrical work in connection with this department will be handled, as at present, by W. C. Adams.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular		Individual	
	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	One Year Ago
Buckwheat	$3.40@4.40	$3.05@3.20	$4.30@4.50	$3 25@3.50
Rice	2.90@3.90	2.50@2.65	3 85@4.10	2.70@2.95
Boiler	2.75@3.75	.....	3.60@3 85	.....
Barley	2.65@3.65	2.20@2.35	3.50@3.75	2.35@2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	One Year Ago
Clearfields	$4.85@5.50	$1.75@2.10	$8.35@8.75	$4.25@5.00
Cambrias and Somersets	5.00@5.75	2.15@2 50	8.50@9.00	4.60@5.40
	F.o.b. Hampton Roads		On Cars, Boston	
	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	One Year Ago
Pocahontas and New River	$6.75@7.00	$2.80@2.90	$10.00@11.00	$5.00@5.25

*All-rail rate to Boston is $2 60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports as compared with a year ago are as follows:

ANTHRACITE

	Circular		Individual	
	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	One Year Ago
Buckwheat	$2.75	$2.75	$6.25@6 50	$3.25@3.60
Rice	2.20	2.25	4.50@5.00	2.50@2.75
Barley	1.95	1 75	3.50@3.75	2 10@2.25

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	South Amboy		Port Reading	Mine Price	
	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	Feb. 17, 1917	One Year Ago
Clearfield	$6.00@6.50	$3.90@4.00	$6.00@6.50	$4 50@4.75	$2.35@2 45
South Forks	6.50@6.75	4.00@4.25	6.50@6 75	5 00@5.25	2.45@2.70
Nanty Glo	6.50@6.75	4.00@4.25	6.50@6.75	5.00@5.25	2 65@2 70
Somerset	6.00@6.50	3.90@4.00	6.00@6 50	4 50@4.75	2.:5@2.45
Quehamoning	6.50@6.75	4.00@4.25	6.50@6.75	4.75@5.00	2 45@2 70

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	One Year Ago
Buckwheat	$2.50	$1.55	$3 40	$2.30
Rice	2.10	.90	3.00	1.80
Boiler	1.95	....	3.15	....
Barley	1.85	.55	2.05	1.30

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Feb. 17, 1917	One Year Ago
Slack	$5.00@5.25	$1.30@1 40
Mine-run	5.25@5.50	1.35@1.45
¾-in.	5.25@5.50	1.40@1.50

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines:

	Springfield	Clinton and Sullivan Cos.
Steam lump	$3.25@3 50	$3.25@3.50
Egg	3 50@3.75	3.25@3.50
Nut	3.25@3.50	3.25@3.50
Mine-run	3.25@3.50	3.25@3.50
Screenings	2 75@3.00	2.75@3.00

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless
Lump	$3.50@3 75	$3.50@3.75	$5.00@5.25
Egg	3.50@3.75	3.50@3.75	5.00@5.25
Nut	3.50@3 75	3.25@3.50	.....
No. 1 nut	3.50@3.75	.....	.....
No. 2 nut	3.25@3.50	.....	.....
No. 3 nut	3.00@3.25	.....	.....
No. 1 washed	3.50@3.75	.....	.....
No. 2 washed	3.50@3 75	.....	.....
Mine-run	3.00@3.50	3.25@3.50	5.00
Screenings	3.00@3.25	3 00@3.25	.....

Hocking lump, $4.00@4.25; splint lump, $4.25@4.50.

St. Louis—Price per net ton f.o.b. mine:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	One Year Ago	Feb. 17, 1917	One Year Ago
6-in. lump	$3.00@3.25	$1.60@1 75	$3@3.25	$1.35@1 50	$3.00@3.25	$1.15@1.25
2-in. lump	.....	1 40@1.50	.....	1.25@1.35	2.75@3.00	.95@1.15
Steam egg	.....	1.40@1.65	2.75@3	.....	2.75@3.00	.....
Mine-run	2.75@3.00	1 15@1.20	2.50@2.75	1.10@1.15	2 50@2.75	.90@1.10
No. 1 nut	3.00@3.25	1.35@1.50	3@3.25	.....	.....	1.00@1.25
2-in. screen.	2.75@3	.85@1.00	2.50	.75@ 85	2.35@2.50	.75@ .85
No. 2 washed	3.00@3.25	1.50@1.60	3@3.25	1.40@1 50	.....	1.40@1.50

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Buffalo—Price per net ton f.o.b Buffalo:

BITUMINOUS

	Feb. 17, 1917		Feb. 17, 1917
Pittsburgh	$5.75@6.25	Pennsylvania Smokeless	$5.35@5.85
Ohio No. 8	5.75@6.25	All Slack	5.60@6.10
Allegheny Valley	5.50@6.00		

PROPOSED CONSTRUCTION

Ga., Atlanta—The Georgia Railroad and Power Co. will extend its transmission lines. W. H. Snow, Pur. Agt.

Ga., Statesboro—The City will soon hold an election to vote on $30,000 bonds to improve the electric-light plant.

Idaho, Grangeville—The Grangeville Electric Light and Power Co. will build a concrete dam. Estimated cost, $40,000 or $60,000. T. A. Bayless, Supt.

Ill., Kewanee—The Kewanee Boiler Co. will soon be in the market for piping specialties such as blow-off valves, automatic stop and check valves, exhaust heads, steam separators and various other details connected with the piping to be installed in the new power plant now under construction. C. E. Bronson, Asst. Mech. Engr.

Ind., White Cloud—The Interstate Public Service Co., Board of Trade Bldg., Indianapolis, will install a hydro-electric power plant.

Iowa, Algona—City will soon receive bids for improving electric-light plant. S. W. Crowell, City Clk.

Kan., Beloit—City is having plans prepared for an addition to the electric-light plant. F. A. Darst, Supt.

Kan., Mullinville—City is having plans prepared for an electric-light plant. Estimated cost, $10,000. W. B. Rollins & Co., Railway Exchange Bldg., Kansas City, Mo., Engr.

Ky., Covington—City Council has retained G. Hornung, C. E., Woolsack Bldg., Newport, to prepare plans for an electric-light plant.

Ky., La Center—La Center Light and Power Co., recently organized, wil enlarge its plant. S. T. Payne, Pres.

Ky., Newport—City is having plans prepared for an electric-light plant. G. Hornung, Woolsack Bldg., Consult. Engr.

Ky., Pikeville—City is having plans prepared for extending the electric-light plant.

Mo., New Cambria—City will soon vote on bonds to install an electric-light plant. E. B. Murray, 920 Walnut St., Kansas City, Engr.

N. Y., Bainbridge—The Standard Light, Heat and Power Co., Unadilla, has applied for permission to install an electric-light plant.

N. Y., New York—(Borough of Manhattan)—Interborough Rapid Transit Co. has had plans prepared for 1-story, 57x120-ft. transformer station. Estimated cost, $150,000. J. H. Campbell, 165 Broadway, Treas.

N .C., Mortimer—C. M. McCorkle, Newton, has purchased a site on Wilson's Creek and will build a hydro-electric plant.

Ohio, Cleveland—The Cleveland Railway Co. is preparing plans for a substation at 2162 Ashland Rd. Estimated cost, $300,000.

Ohio, Dayton—The Dayton Power and Light Co. has applied to the Commissioners of Montgomery County for permission to build a transmission line in Smithville and Marshall Rd., Van Bureans Township.

Ohio, Delphos—The Northwestern Ohio Light Co., a subsidiary of the Federal Power and Light Co., Boston, is having plans prepared for rebuilding the transmission line between Delphos and Van West, including a substation and coal conveying system. Estimated cost, $100,000. R. A. Longworthy, Boston, Ch. Engr.

Ohio, Lorain—The Lorain County Electric Co., Broad St., Elyria, is having plans prepared for a 1-story, 100x200-ft. power house. Estimated cost, $50,000. J. B. Johnson, Secy. and Gen. Mgr.

Ohio, Springfield—The Springfield Light, Heat and Power Co. has had plans prepared for improving its electric-light plant.

Okla., Amorita—City is having plans prepared for an electric-light plant. C. H. Peebles, Arch.

Okla., Wanette—City voted $80,000 bonds to install an electric-light plant.

Penn., Mahanoy City—The Reading Coal and Iron Co. will install an electric power plant at its Knickerbocker mine.

Penn., Philadelphia—The Quaker City Iron Works has filed the plans for a boiler house and engine plant at Salmon and Tioga St.

Penn., Pittsburgh—The Scranton Electric Co. has had plans prepared for a plant. D. T. Campbell, Scranton, Mgr.

S. D., Alexandria—City will soon vote on $18,000 bonds to enlarge the electric-light plant.

Tenn., Hartsville—The Hartsville Light and Ice Co. will install an electric-light plant. C. M. Gwinn is reported interested.

Tenn., Somerville—City will enlarge the electric-light plant.

Tex., Port Arthur—The Port Arthur Light and Power Co. will build an addition to its electric generating station. Stone & Webster Engineering Corp., 147 Milk St., Boston, Engr.

Wash., Oroville—The West Okanogan Valley Irrigation Dist. has been granted a franchise to construct electric transmission lines.

W. Va., Hartland—(Clarksburg post office)—The Hartland Power Co. has had plans prepared for an electric generating station. W. S. Barstow & Co., 50 Pine St., New York, Engr.

W. Va., Raleigh—A. D. Preston, Beckley, and C. L. Miller, Hinton, have purchased a tract of land along the New River and will build a hydro-electric plant and will supply electricity to the coal-field communities in the county.

Wis., Merrimack—Cities of Merrimack, Sumpter and Prairie du Sac are considering plans for distributing systems and transmission lines to connect with the hydro-electric plant in Merrimack.

Wis., Rothschild—The Marathon Paper Mills Co. is having plans prepared for a power house. Vaughn & Meyer, Majestic Bldg., Milwaukee, Engr.